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DEVELOPMENT OF MOBILE TRAVEL GUIDE APPLICATION FOR MUSEUMS

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In recent years, the development of worldwide travel has been outstanding. At the same time, due to the fast development of the travel business, it is important to offer tourists an enhanced travel platform. In China, most of museums still use narrators to do presentation about exhibition. In order to support museums to provide service in various ways, online product is essential. During the research process for completing this Thesis work, a mobile travel guide application was developed according to the existing condition of museums, which is based on an existing application.

The objective of this project was to develop a mobile travel guide application with added functions to an existing application. The main goal of the application is to provide a wide variety of functions for museums to benefit visitors to museums. Moreover, this application aims to reach the right target group, and do real-time data analysis.

The research draws from the actual demand analysis, developing a mobile application on the Android operating system. The application is an interaction application, and is added with some functions that are different from the existing one. The constructive research method was used to specify and analyze possible existing problem, in order to achieve a satisfactory result. Database concept was studied to construct database for the application. Usability studies were used to create graphical interfaces.

There were several tools used in the development. Android studio was utilized to create the Android development environment. Hierarchy viewer is a tool to examine and design the User Interface. The test tool Android Virtual Device Nexus 5 in Android studio was mainly used for program automatic testing. The outcome of this research is a practical and easy application that everyone is able to use. It includes basic function which is textual and audio explanation, and added functions which are online ticketing sale and online shop service.

Key words   Mobile application, Android

CONTENTS

SYMBOLS AND ABBREVIATIONS

CSS   Cascading Style Sheet

HTML   Hyper Text Markup Language

JS   JavaScript

GUI   Graphical User Interface

SDK   Software Development Kit

JDK   Java Development Kit

AVD   Android Virtual Device

SaaS   Software as Service

VoIP   Voice over IP

FIGURES AND TABLES

1 INTRODUCTION

1.1 Background Information and Motivation

The thesis research focuses on the development of the mobile travel guide application by applying software engineering principles and software development methods based on an existing one. "Mobile tourism is an emerging trend in the field of tourism involves the use of mobile devices as electronic guides" (Smirnov, Kashevnik, Balandin & Laizane 2013, 94). Users are able to get enriched travel information on the Internet; however, there is a limitation to get information timely when they are on move (Jinendra, Bhagyashri, Pranav, Seema & Parag 2012, 1). From museums' perspective, users are able to use the application with and without network, which helps museums to be known by more tourists. In the process of development, a use case diagram and structure diagrams were described. In this research, the existing condition, design idea and implementation methods of application which were built on Android environment were described. Furthermore, the analysis and design of the application were based on the actual using situation.

There is one personal motivation of this research. During the practical training we both developed a basic mobile application in Germany for a company called stARTistics. Therefore, with this experience and knowledge acquired, we decided to develop additional functions based on the existing application. A German company called stARTistics commissioned this research. Both researchers Mi Hu and Yu Weng did their practical training in this company. During the practical training, we designed the basic framework of the application, constructed database and analysed Chinese museum market in China. Moreover, we did preparation work which includes employed staffs to write texts, record audios and take pictures. The Creative Director knew we planned to develop more functionalities for the application, he was very supportive and was ready to answer any questions that we had during the research process.

This research will be of benefit to museums those want to benefit from online products, such as ticketing and souvenirs sales. Using the travel guide application on mobiles for free has become a trend due to the increase in the use of mobile

equipment. There are not many people spending money to rent audio guides in museums. Therefore, mobile travel guide applications have the development value if museums want to attract more tourists.

1.2 Objectives and Scope

The main objective of this research is to develop a mobile travel guide application with added functions to an existing application. Especially in this application, interaction between users is the new function compared to traditional travel guides for museums. We decided to design this application because a lot of people think there are similar products already exist on the market. However, after we conducted the market research, there was only one single function on most of travel guide applications, and full-featured products were not listed. Thus, the purpose of designing this product is to make a travel guide application which contains possible integration of a number of features. Therefore, users may use a more convenient application. Online ticketing and online shop sale services allow users to buy tickets and souvenirs anywhere with an access to a network. Therefore, it is unnecessary for users to go to museums personally.

This thesis research provides a new mobile application in the "Online Travel Tool" field. Firstly, the research focuses on the museum travel guides. Secondly, the application has supporting functions, such as online ticketing sale, online shop service, and audio guide. Thirdly, these research issues are focused on the traditional travel guide application.

1.3 Research Questions and Research Methodology

Based on the objectives and the scope of this work, the following research questions are addressed.

1. What added functions will be designed in the travel guide mobile application?

    In order to design added functions to the mobile travel guide application based on an existing one, it is important to have a plan of design concepts and design methods. Answers to this research question is online ticketing sale and online shop service. The thesis describes the process of functions design in the

mobile application. Software engineering principles are an essential framework to guide the design.

2. What benefits will users and museums acquire from the application?

   This thesis analyses the market of travel guide mobile applications in order to study the impact of mobile application on users and museums. Comparing with to the existing mobile applications is important to know what advantages our application has.

The research method used in this study was constructive research and questionnaire. The travel-guide application design theory was presented in this research, and this theory was based on our practical training company's application. On this basis, there are development functions designed on this mobile application, such as digital shop and online-ticketing.

This thesis involves mostly development work based on the literature. The research is developmental and explanatory because it makes clear understanding of how the mobile application was accomplished and the production processed.

Due to the fact that this research is the development work, there are some development tools to be used in this study. For instance, the mobile application under development was based on the Android operating system. Therefore, Hierarchy Viewer was a mandatory tool. It comes with Android and it is the Android APP development tool that helps us to better examine and design the user interface (hereinafter UI). Hierarchy Viewer has two main functions as follows:

1. Intuitive access to UI layout structure and properties of a variety of information from the visual point of view, help us to optimize the layout design;

2. Combined debug help observe specific UI objects and requestLayout process invalidate operation.

The two features illustrated above are the reasons we chose to use it. Hierarchy Viewer is able to help us better review and design UI. Therefore, it was found useful to use in conducting this research.

1.4   Assumptions and Limitations

This mobile travel guide application available is limited to the recent operating system versions. For instance, the application is available on smartphones with the recent Android operating system. However, this application is new, the data of museums which we corporated in application may need more time to upgrade.

In addition, in order to implement the mobile application, we needed to pay the staffs who have professional skills to record the audio and write museums' descriptions. Consequently, the practical demonstrations are limited by financial and human resources.

1.5 Structure

This thesis is divided into 7 chapters. Chapter 2 introduces development details and tools. Chapter 3 focuses on analyzing the application. Chapter 4 describes the development details. Chapter 5 presents the operation of the mobile application. Chapter 6 lists the steps of system test. The final chapter, chapter 7 draws the conclusion of the thesis and discusses the benefits of the mobile application.

2 SYSTEM DEVELOPMENT ENVIRONMENT AND TOOLS

2.1 Android Development Environment

Java programming language was chosen for this research, meanwhile it needed to be debugged by using AVD. Android Studio is recommended by Google as the Android application development tool. In order to finish the development of Java programming language, an easy used tool JDK is needed.

However, there is a big difference between Android application development and Java development, Android SDK is necessarily used as well. In addition, there are a few self-made images need to be inserted, Photoshop is a good tool to process pictures.

2.2 Development Tools

Android Studio

Android Studio is a "fairly new IDE (Integrated Development Environment) made available for free by Google to Android developers", it is "based on IntelliJ IDEA, an IDE that also offers a good Android development environment" (Govender 2014). Compared with Eclipse, Android Studio has better startup time, response speed and memory usage. What's more, it has smarter editor which absorbs advantages of Eclipse and ADT, and has real-time preview of interface as well. Studio also supports every plugin, such as Git, Markdown and Gradle. Figure 1 presents the interface of Android Studio.
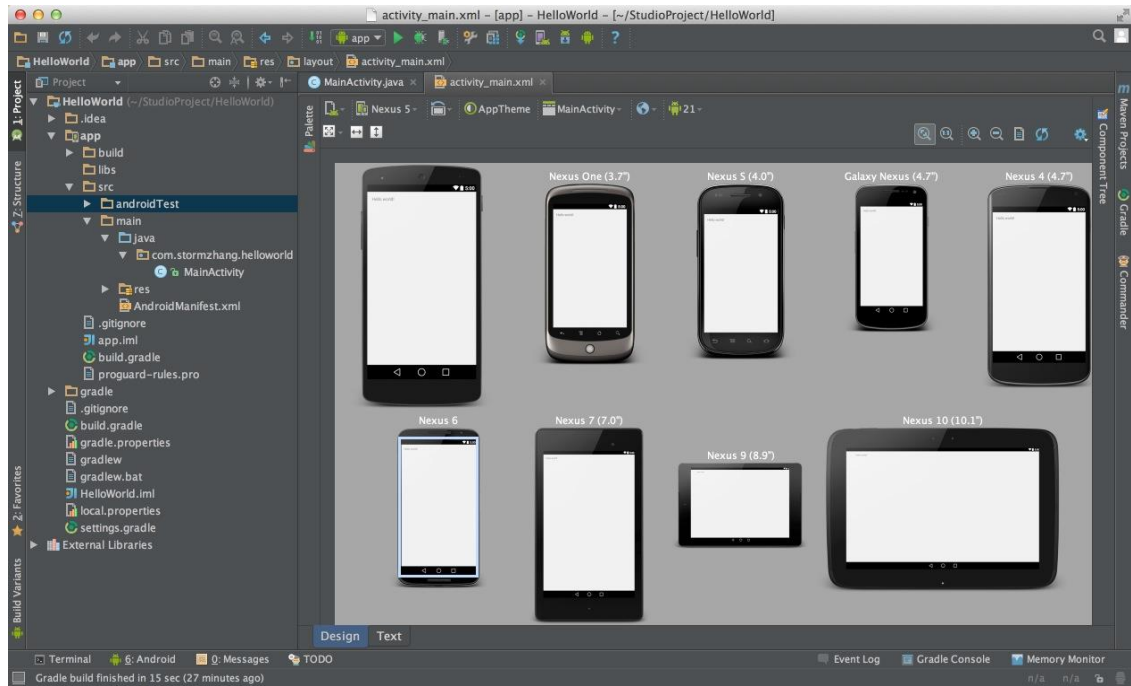
Figure 1. Interface of Android Studio (stormzhang 2014)

Android SDK and JDK

Android SDK is "the Android Software Development Kit contains the necessary tools to create, compile and package Android applications", and "the primary way to develop Android applications is based on the Java programming language" (Vogel 2015).

Every programming language has its own SDK, and it is available for various languages. The SDK for Java is called JDK, the Java Development Kit, which is included in SDK.

Java Programming Language

Java programming language is "designed to have the 'look and feel' of the C++language". It "can be used to create complete applications that may run on a single computer or be distributed among servers and clients in a network", and "build a small application module or applet for use as part of a Web page" (Rouse 2007). Java has the following major characteristics. Firstly, programs created by Java are portable in network. The source program compiled into with Java is bytecode, it can be run both on a server or a Java virtual machine.

Secondly, Java code is "robust" because of its safety inspection rule. Thirdly, Java is object-oriented which is easier than C++ (Rouse 2007).

Photoshop CS3

Photoshop was originally released in 1990 and has been popularly used for 25 years. It was created by Adobe Systems and it is the "predominant photo editing and manipulation software" for both professionals and beginners (University of Washington 2014). On one hand, with Photoshop every picture is able to be created and edited professionally. On the other hand, it is easy to begin editing the pictures (Soffar 2015). Photoshop is used for editing pictures in this thesis.

3   ANALYSIS OF MOBILE TRAVEL GUIDE APPLICATION

3.1   Requirements Analysis

Requirements analysis "also called requirements engineering, is the process of determining user expectations for a new or modified product" (Rouse 2007). The precondition of application used is a wide range of user participation. Therefore, the functional specification needs to be generated according to the user requirements. Besides, the requirements determined every function priority inside the application.

According to the current situation of mobile travel guide application and user demands, there are a few functions added and improved to the existing one. Before designing the application, we made a questionnaire available on a website called wenjuan.com. There were 177 responses to a questionnaire collected from common mobile phone users; they were School Mates from Lapland University of Applied Science and our friends. The results were analysed by the system automatically. In the survey, 65.34% of the respondents represent the age group of 18-25 years. A total of 96.59% of all users are using smart phones and 55.68% are using Android system. One of the questions asked was as follows: "If there is a travel guide application for you, what functions you think are necessary?" Figure 2 shows the result.
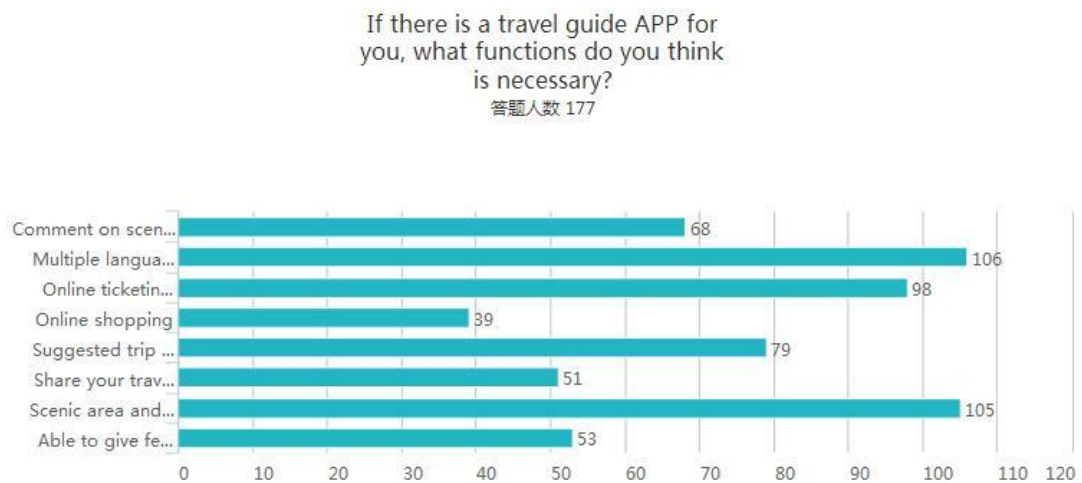

Figure 2. What functions are necessary to obtain?

Firstly, through the questionnaire result and combining our own thought, online ticketing and online shopping services were chosen to be designed. As the Internet penetration gets higher and higher, modern people's life style has changed a lot. Literature also points out this aspect by stating that "Since the Internet has made things simpler", there is no reason to stand in the long lines to get one ticket, because by touching a few keys on the phone one can buy tickets easily (Roben 2014). Considering other aspects, secondly, login function with valid email address and password should be provided for users, and the system should be able to manage and maintain all user accounts. Thirdly, the application should be able to add and publish new scenic spots information. It includes texts, audios and photos, and it needs to be displayed properly on the mobiles. Fourthly, the information should be able to be modified and maintained in the application, which includes user login information, scenic spots information, online ticket information and shop product information. Fifthly, after the application is getting online, users are able to give feedback and post their own suggested trip itinerary on website or in scoring system.

3.2   System Analysis

The use case is "a methodology used in system analysis to identify, clarify, and organize system requirements" (Gibilisco 2015). Based on the requirement analysis, a use case diagram was built as Figure 4 shows below. Since the application is used for both internal access and external access, the diagram illustrates different access rights of different user groups and provides all of the possible function of the application from user and administrator points of view. There are two groups of users, user and administrator. Moreover, according to the application character, there are four aspects of functionalities which are content management, account management, ticket order and product order.
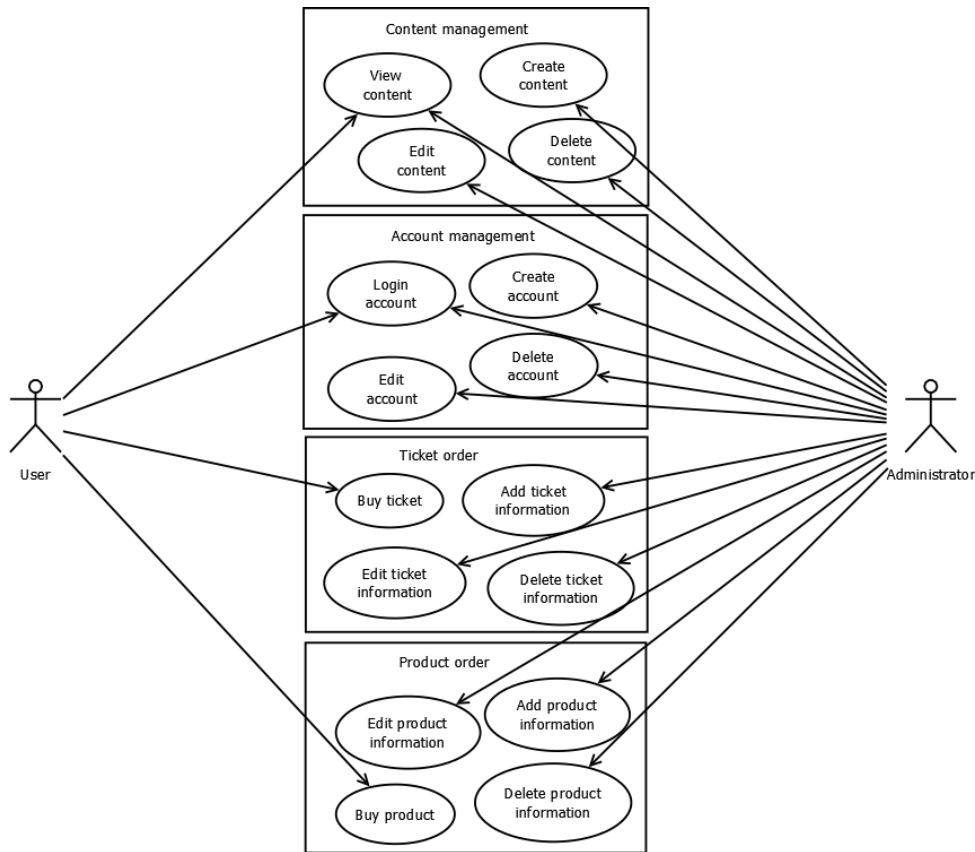
Figure 3. Use case diagram

As Figure 3 shows above, the first functionality is content management. "A content management system (CMS) is a system used to manage the content of a Web site" (Rouse 2011). All data and information are created, edited, deleted and maintained here. However, only the administrator has right to do these operations. Once there is content added or modified by the administrator, the old content will be updated in the system. The user is only able to view the content.

The second functionality is account management. There are two kinds of accounts, one of which is the user account, and the other is the administration account. The user needs to register an account with an email address and set a password first and then login. If the user wants to change the password, he or she will receive a validation link in the mailbox. Only if validation is successful, the user has right to make changes. Besides, the user does not have any other access rights. The administrator has full access to operate every function, i.e. he is able to login, create, edit and delete accounts. Normally, the administrator will not delete any account, except if there is a threat to the system.

The third functionality is ticket order. With this function, when the user inputs a keyword e.g. Louvre, the system will show the ticket price of Louvre Museum. Furthermore, if the user buys several tickets, the system will calculate the total price automatically. The user is able to combine bank card with his or her account. After paying the payment, the user will receive an E-ticket through phone. On the other hand, the administrator is responsible for updating the ticket information in time, which includes add, edit and delete.

The forth functionality is the product order. This function provides a platform of online shopping to the user. It is similar to the ticket order, i.e. the user inputs any museum's keyword, and the museum's product will display. There is also the functionality of product introduction and price. The administrator has access right to add, edit and delete product information.

3.3   Structure Analysis

In order to make the application complete with high efficiency and match the requirement analysis, the user and administrator must have their own access control. The application is divided into two parts, i.e. user interface and administration. The user interface is designed to users, and administration is from backend to manage all user accounts and data.

User Interface

With the rapid development of technology, "most of the time users are not sure of what and how they will be using the new systems and their yardstick for the requirement comes from their current system/process" (Bhatnager 2011). What is more, "most users expect a system to adapt to their preferred way of working and to be more interactive rather than being required to change their processes to accommodate the systems themselves" (Bhatnager 2011). Unquestionably, the user interface should be as simple as possible and with practical functions as well. It is extremely important to catch users' eyes at first time.
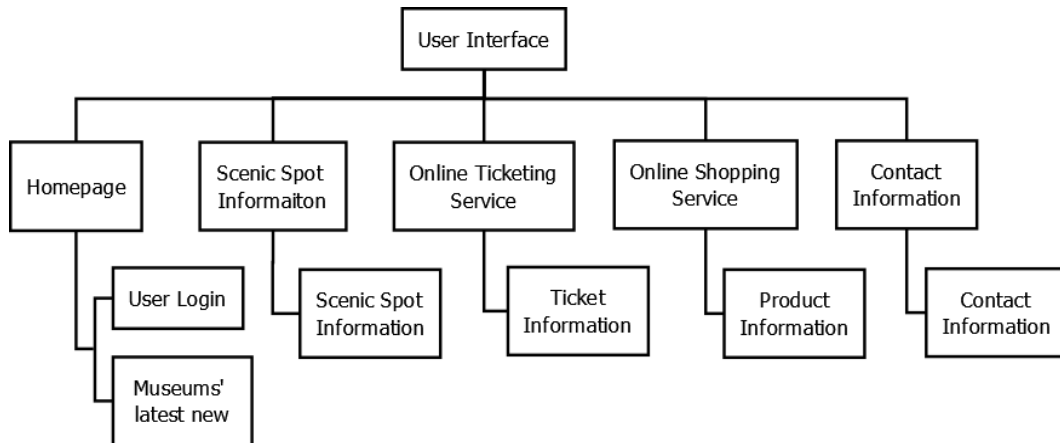
Figure 4. Structure of user interface

As Figure 4 shows above, there are the following models in user interface:

User login model

Museum relevant news model

Scenic spot information model

Ticketing service model

Shopping service model.

The above models are listed to show what functions users are able to use. What is more, in sub-models there are detailed introduction of every model.

Administration

The administration is the backend and it is a private operation. The responsibility is to manage user accounts and update content data. The data is used for different functions' information display. To ensure the security of the system, the username and password are necessary when the administrator logs in. The entry of administration is placed in the case company's internal website. Every function of administration structure is simple to use, even for people who do not have IT background.
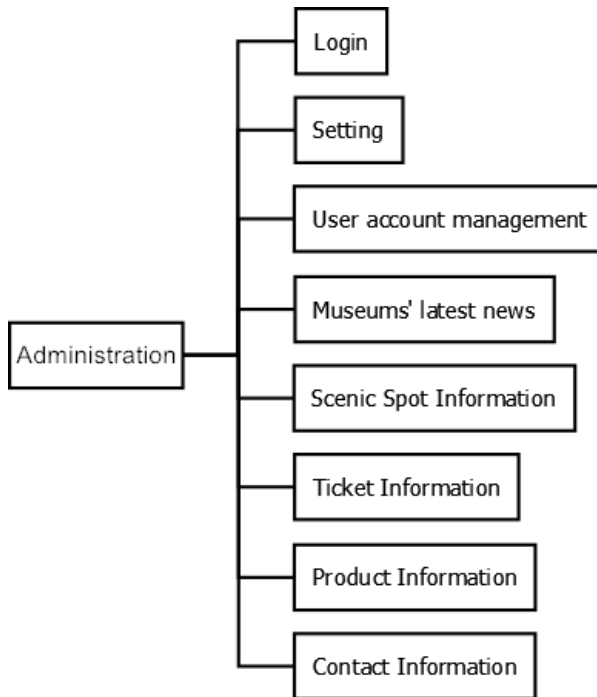
Figure 5. Structure of administration

As figure 5 shows above, there are the following models in administration:

Administrator login model
Setting model
User account management model
Museums' news model
Information model
Ticketing service model
Shopping service model.

The above models are listed to show what limit of authority the administrator has. It is all-sided that the administrator is able to operate every aspect of the mobile travel guide application, in order to provide updated and timely information.

4   APPLICATION DESIGN

4.1   User Interface Design

According to the requirements, the mobile travel guide application includes four main user interfaces. Further, the analysis of each user interface is necessary, to analyze what kind of content should be involved. GUI is a "graphical user interface to a computer" (Rouse 2006). In GUI design aspects, the design of user interface comprises the following steps:

● UI Designer – user interface design process – Theory of identification of users and context: "usability analysis outlining potential user capabilities of the product vs. the initial business and functional requirements and limitations" (Sergeev 2016).

● UI Designer – user interface design process – Theory of navigation and structure: "the UI-structure outlining the pattern of product's interface and the path the user follows while browsing the website (in accordance with the user scenarios and roles)" (Sergeev 2016).

● UI Designer – user interface design process – Theory of compositional interface design: "the UI-design featuring a catalogue of the key screen interface forms and requirements to location, priority, form and content of information, graphical and functional elements" (Sergeev 2016).

● UI Designer – user interface design process – Theory of visual interface design: "the GUI-design outlining visual standards of information, graphic and functional interface elements" (Sergeev 2016).

There are four user interfaces designed shown as below, which are homepage, audio page, ticket page and shop page. The design of each page is simple and clear (Jin & Yao, 2009).

Once the user enters the Homepage interface, the system will request the user to input the correct Email address and password to login. Furthermore, recommended museums and museums' recent activities are displayed on the view. It is simple for users to find their ideal museum. The interface of homepage is shown in Figure 6 below.

Figure 6. Interface of Homepage

In the scenic spot information interface, users are able to listen to audio guides, read text guides and view pictures. Figure 7 depicts the interface of scenic spot information.
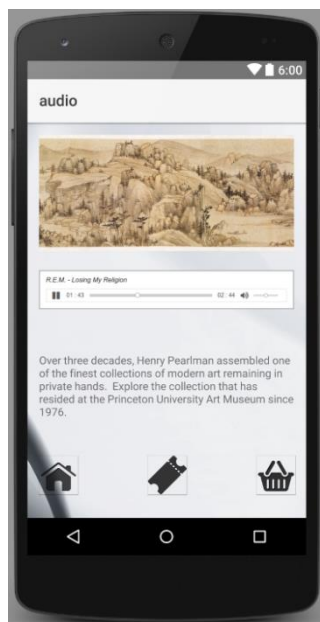

Figure 7. Interface of scenic spot information

The ticketing sale interface is designed for users to search and order museum tickets. The tickets information includes purchase date, punch date, ticket amount, price and tickets code. Figure 8 demonstrates the interface of ticketing sale.
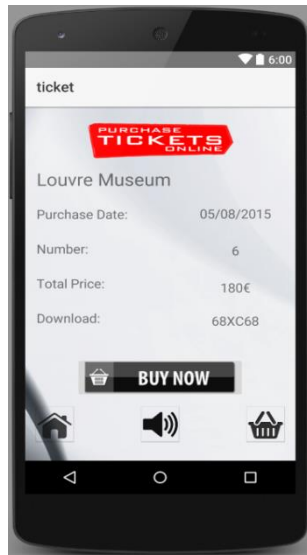

Figure 8. Interface of ticketing sale

The online shop product information interface presents the current museum's related products. The product information includes introduction and price. The shop interface is shown below in Figure 9.

Figure 9. Interface of online shop

4.2   Database Design

Database design of the application followed the relational model concept. The relational model is "the formal model of a database that was developed for IBM in the early 1970s by Dr. Edgar Frank Codd" and "all modern relational databases are based on this model" (Jewett 2016). Furthermore, it was designed for "representing information which does not appear in UML model but is needed for us to build functioning databases" (Jewett 2016).

There are four kinds of data required to store, and they rely on the normalization rule. Normalization is "the process of organizing data in a database", and it includes "creating tables and establishing relationships between those tables according to rules designed both to protect the data and to make the database more flexible by eliminating redundancy and inconsistent dependency" (Microsoft 2013).

Every page has its ID. Homepage's ID is the primary key, and other sub-pages' IDs are stored as widget component. Furthermore, other data has its own property. In the design of relational database, the SQL data definition and query language were used to store information. Part 1 is the item of homepage that shows log-in table and museums' recommendation. Part 2 is the item of text guide and audio guide. Part 3 is the item of shop products. Further, part 4 is the item of tickets insert. The database was named as "MuseumApp.db", and there are four tables.

In Table 1. App_home, there are primary key id, component id number, recommend museums, picture of museums and museums' advertising picture. The data type of these properties are, in order, "Integer", "Integer", "Text", "Image" and "Image". The detailed description is described in the table.

Table 1. App_home

Property	Data Type	Description
_id	Integer	Automatic increase of the primary key
widgetId	Integer	Component ID number
MuseumName	Text	Recommend Museum
MuseumPic	Image	Picture of Museum
News	Image	Museum Advertising Picture

In App_audio (Table 2), the property includes the component id, picture of museums audio guide of museums and text guide of museum. The data type of these properties are "Integer", "Image", "Text" and "Audio", in that order.

Table 2. App_audio

Property	Data Type	Description
_id	Integer	Store widget component ID
MuseumPic	Image	Picture of museum
AudioGuide	Audio	Audio guide of museum
TextGuide	Text	Text guide of museum

Table 3. App_shop contains the component id, picture of museums, introduction of products and price of products. The data type of property "_id" is "Integer", "MuseumPic" is "Image", "ProductIntro" is "Text" and "ProductPrice" is "Double".

Table 3. App_shop

Property	Data Type	Description
_id	Integer	Store widget component ID
MuseumPic	Image	Picture of museum
ProductIntro	Text	Introduction of product
ProductPrice	Double	Price of Products

There are component id, museums' name, price of tickets and date of tickets in Table 4. App_ticket. The data types of every property in App_ticket (Table 4) are "Integer", "Text", "Double" and "Timestamp", in that order.

Table 4. App_ticket

Property	Data Type	Description
_id	Integer	Store widget component ID
MuseumName	Text	Name of museum
TicketPrice	Double	Price of ticket
TicketTime	Timestamp	Date of ticket

4.3   Program Module Design

According to the function analysis, this application should include the program starter, user interface, backstage service and database processor (Wang, Zhang & Shen, 2010). The relationship between every module is shown in Figure 10.
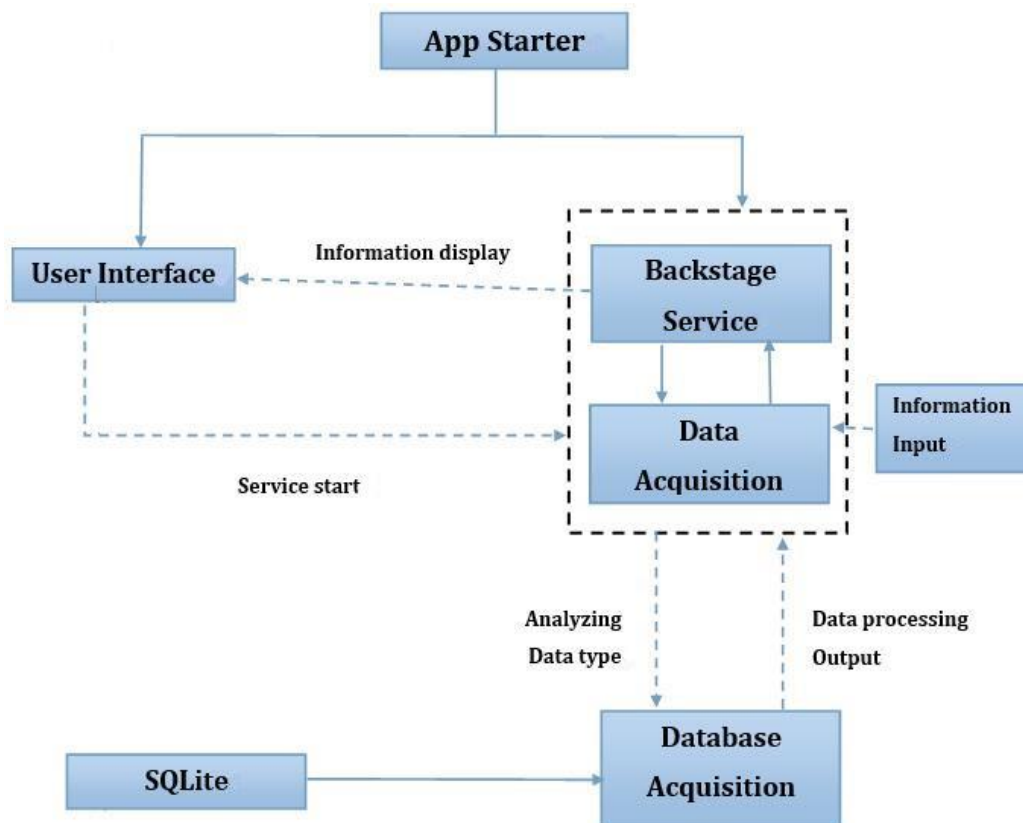

Figure 10. Module Relationship Diagram

The most important parts of this application are the Backstage Service and Data Acquisition Module. The Data Acquisition Module is in charge of data collection, data processing and sending the requirements data to the User Interface. The Backstage Service is running when App Starter is switched on, and after the Backstage Service turns on, it is going to keep the running status.

The User Interface obtains the museums' and log-in information from the database module. Data Acquisition Module processes with analyzing and dealing with required information, and then sending the information to Backstage Service, to enable the User Interface to update the information in time from Backstage Service.

The Data Acquisition Module and the Database Acquisition Module include all kinds of method for SQLite manipulation. The User Interface and Backstage Service are both reliant on the Data and Database Acquisition Module to achieve the functionality. After finishing the user interface design, database design and module design, the programming design phase was basically completed.

5 PROGRAM DEVELOPMENT

5.1 Documents' Structure and Purpose

At the beginning of the program development stage, the construction name was determined as "travelguide". According to the contents of module design, a primary group called "travelguide" was necessary to be created. The program's source code structure is shown in Figure 11.
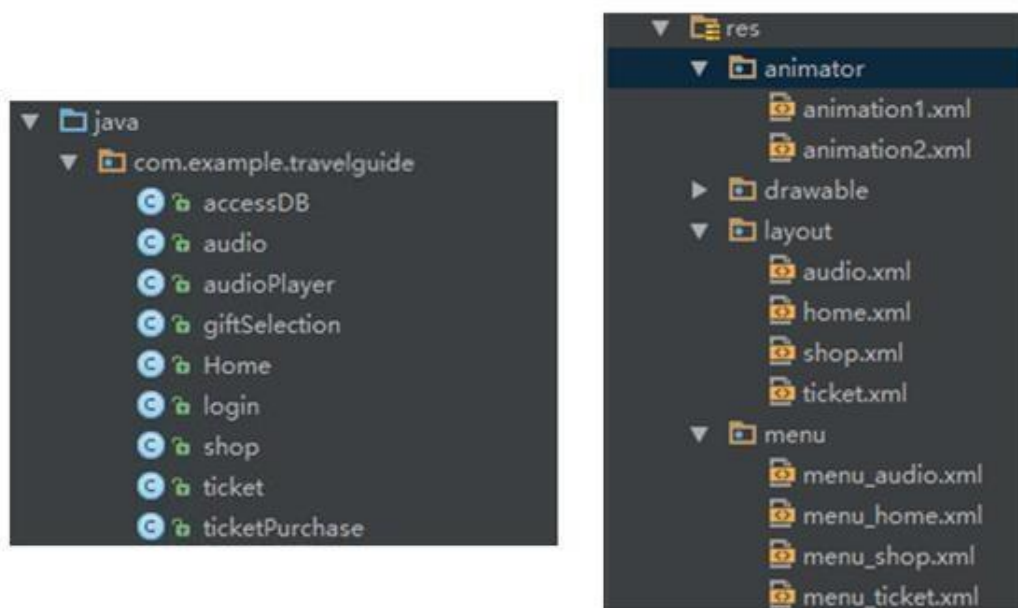

Figure 11. Source Code Structure

In the source code structure shown above in Figure 11, the main java code has nine sections. The resource includes animator, layout and menu. Besides, the animator has two sections which are layout and menu. There are four sections under the layout, and four sections under the menu.

Table 5. Name of Source Code and Explanation

Files Name	Explanation
accessDB.java	App information view from database
Audio.java	User interface functions in audio page
audioPlayer.java	Set up an audio guide
giftSelection.java	Souvenir clickable
Home.java	User interface functions in home page
login.java	Customers log-in box
Shop.java	User interface functions in shop page
Ticket.java	User interface functions in ticket page
ticketPurchase.java	Ticketing function enable

In order to make the structure of the source code files clearer, there were multiple domain names and space set up in the primary group "travelguide". They were used to save user interface, database and functional code documents. Table 5 above is the name of the source code and explanation.

Table 6. Purpose of Each Resource File

Resource Directory	Files Name	Explanation
animator	animation1.xml	Animation for interface mutual transformation
	animation2.xml	
drawable	audio.png	These pictures are used in project, such as click button, user interface logo and so on.
	home.png	
	ticket.png	
	shop.png	
	bg3.jpg	
	museum1.png	
	news1.png	
	onlineticket.png	
	sourvenirs.png	
	......	
layout	Home.xml	Home page interface
	audio.xml	Audio page interface
	ticket.xml	Ticket page interface
	shop.xml	Shop page interface

The source files of Android were saved in /res. Herein, the /res/animator directory was stored in XML files about generating animation, while the /res/drawable directory was stored in image files, and the /res/layout directory was stored in user interface XML files. All resources in the program development phase can be stored in these directories (Young 2001). The specific purpose of every resource file is shown above in Table 6.

5.2   Core Code of Mobile Travel Guide Application

Showing information from database

There are a lot of information needed to be obtained from the SQLite database. For instance, the museums' activities always require update the recent data in real time, and these data are saved in database. Therefore, application client

requires a method to connect database. The main code involved with creating database is shown in Figure 12.

```
private static class DatabaseHelper extends SQLiteOpenHelper {
//database name
private static final String DATABASE_NAME = "travelguide.db";
//database version
private static final int DATABASE_VERSION = 2;
//Constructor
public DatabaseHelper(Context context) {
    super(context, DATABASE_NAME, null, DATABASE_VERSION);
}
    public void onCreate(SQLiteDatabase db) {
    //create travelguide_widget table
    public void onCreate(SQLiteDatabase db) {
    //create travelguide_widget table
    db.execSQL("CREATE TABLE " + TABLE_WIDGET + " ("       ......);
    //create museum_activities table
    db.execSQL("CREATE TABLE " + TABLE_ACTIVITY + " ("     ......);
      }
  }   //rewrite onUpgrade () method
    @Override
    public void onUpgrade(SQLiteDatabase db, int oldVersion, int newVersion) {
        ......    }  }  }
    }
}
```

Figure 12. Code of Creating Database

Creating the database needs to make the database name, database version and constructor properly. Further, this code is to create the application widget table and museum_activities table.

Creating Audio Player in Android Studio

The audio guide is one of the basic functions in the mobile travel guide application. All of the audio files were stored in the database, and the users are able to download them. The main code to implement the audio player is shown in Figure 13 below.

```
public class audioPlayer {
    AudioPlayer mp = new AudioPlayer();

    // Set data source -
    setDataSource("/sdcard/path_to_song");

// Play audio
    mp.start();

// Pause audio
    mp.pause();

// Reset mediaplayer
    mp.reset();

// Get song length duration - in milliseconds
    mp.getDuration();

// Get current duration - in milliseconds
    mp.getCurrentDuration();

// Move song to particular second - used for Forward or Backward
    mp.seekTo(positon);// position in milliseconds

// Check if song is playing or not
    mp.isPlaying();// returns true or false
}
```

Figure 13. Code of Implementing Audio Player

The code above is regarding to create the audio player. The functionalities include searching audio resources, starting to play and pause the audio. The audio player will judge the audio's length duration and current duration. Furthermore, it will check if the audio is playing or not automatically.

Ticket Purchase Function Method

The travel guide application contains the tickets payment function. However, there is no need to add the competence of android.permission.INTERNET and

android.permission.ACCESS_NETWORK_STA-TE in debugging stage. Therefore, the main code was only implemented to turn into the payment step. The specific code is shown in Figure 14 below.

```java
public class ticketPurchase {
  package com.example.blogforzfb;

  import android.os.Bundle;
  import android.view.View;
  import android.app.Activity;

  public class MainActivity extends Activity {

    @Override
    protected void onCreate(Bundle savedInstanceState) {
      super.onCreate(savedInstanceState);
      setContentView(R.layout.activity_main);
      findViewById(R.id.button1).setOnClickListener(
          new View.OnClickListener() {
            @Override
            public void onClick(View v) {
              // TODO Auto-generated method stub
              // get Fiap object and pass to container
              Fiap fiap = new Fiap(MainActivity.this);
              // payment method calls, and input payment amount
              fiap.android__pay(0.01);
            }
          });
    }

  }
}
```

Figure 14. Code of Ticket Payment Function

"Fiap object" refers to the product that the user chooses. Once the product is confirmed, the information will be passed to the container. After that, the payment method will be selected, and the payment amount will be displayed.

5.3   User Interface Layout

The travel guide application contains four main pages, which are Home.xml, audio.xml, ticket.xml and shop.xml. In the user interface design, AppWidget frame structure was adopted and intuitive interaction was provided. Four user interfaces were designed in a simple style and easy to operate. The detailed content of each of them are shown below. Figure 15 displays the content of Home.xml, Figure 16 illustrates the content of audio.xml, Figure 17 demonstrates the content of ticket.xml and Figure 18 shows the content of shop,xml.

The content of homepage covers images, text and buttons. After determining the basic pattern, the sub-objects need to be set. For instance, "imageLeft" is located on the left side of the screen. In order to set an image of a museum. Therefore, "museum1" is the sub-object of the "imageLeft".
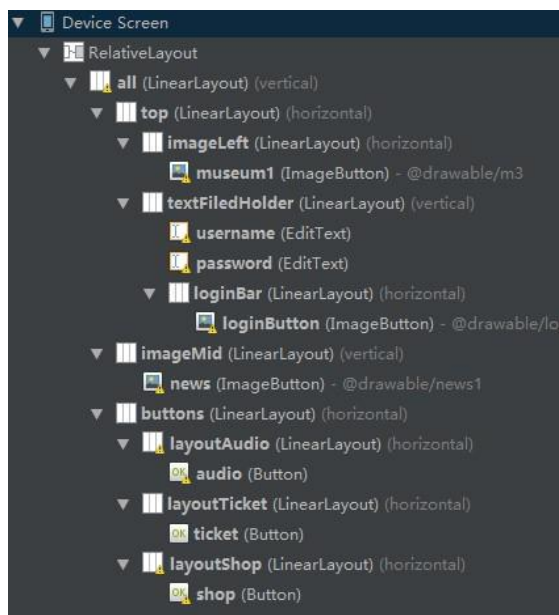

Figure 15. Content of Home.xml

The content of audio includes images, text and buttons. The "audioPicHolder" is a picture folder of the item that audio talks about. Therefore, "audioPic" is the sub-object of "audioPicHolder".
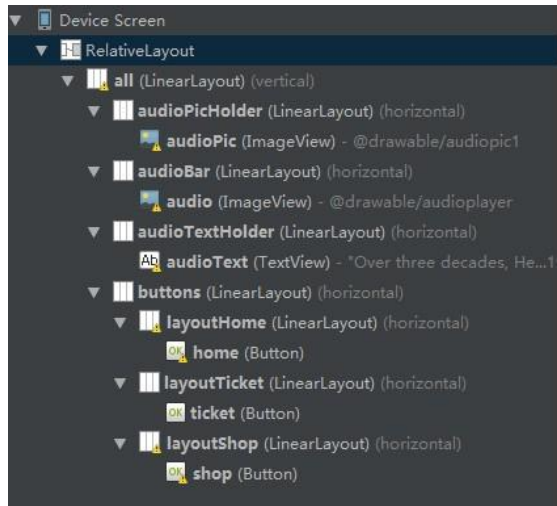
Figure 16. Content of audio.xml

The content of ticket-page contains text, buttons, image buttons and image. "TicketTopview" is located on the upper part of the screen, and this section is for the image which is "tickets". Hence, "imageView" is the sub-object of the "ticketTopView".
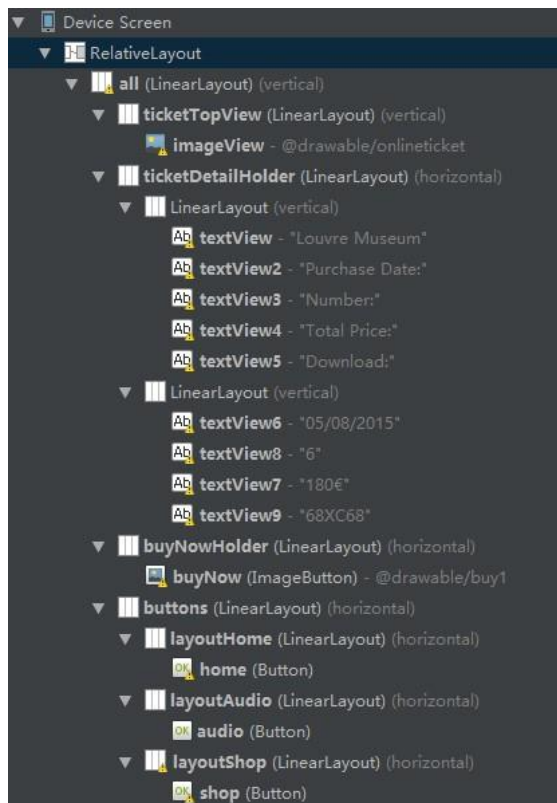

Figure 17. Content of ticket.xml

The content of shop-page has image view, image button and buttons. For example, "topBar" is on the upper part of the screen, and this part is for setting an image which represent "souvenir". Therefore, "souvenir" is the sub-object of the "topBar".
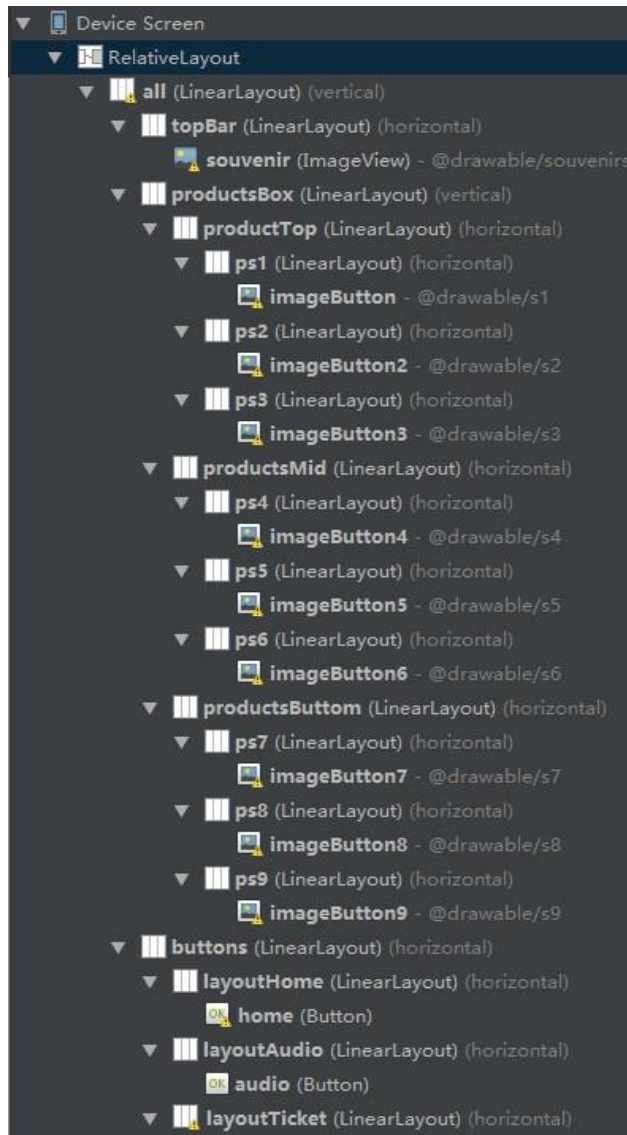

Figure 18. Content of shop.xml

6   SYSTEM TEST

6.1   Starting Android Virtual Device

So far, the coding work has been completed. The travel guide application is ready to be tested, and the test steps and results are described in this chapter. The Android virtual device Nexus 5 was used, and the test system was Android 5.1.1. As shown in Figure 19.

Figure 19. Interface of Virtual Device

The interface of virtual device is extremely similar to the real device. On the upper left corner of Figure 19, there was the text "Android". On the upper right corner, there were signal symbol, battery status and user button. In the mid position, time and date information were presented. At the bottom, it was possible to use mouse sliding to unlock the virtual mobile phone. The boot speed of virtual device depends on how much size of Disk is given by the computer. For this testing, one Gigabyte size Disk was set for virtual device.

6.2   Starting Mobile Travel Guide Application

Unlocking the AVD, and choosing "TravelGuide". The application ran successfully, the user was able to type in log-in box. The status were displayed in Figure 20 and Figure 21.

There were several default icons on the mobile screen in Figure 20. However, due to the test was under a virtual environment, not all of the functions could be used, such as camera, maps and email. The travel guide application icon was the second last of the bottom row. The name was titled as "TravelGuide".

Figure 20. Interface of Mobile Screen

On the homepage, the user was able to input his/her email address and password to log in the system. The picture in the middle included museums' news and information, in order to let users know some museums' activities directly. Further, users were able to jump to audio, ticket and shop page by clicking three icons at the bottom.
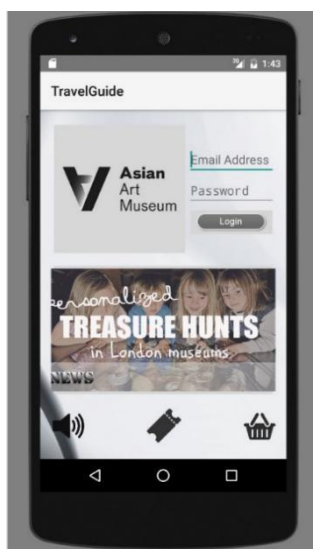

Figure 21. Interface of Homepage

6.3   Other Pages

Clicking "tickets" button, the page turned into ticketing service page. As shown in Figure 22. In the ticketing service interface, the user could operate ticket information easily, such as purchase date, number of tickets and total price. "BUY NOW" is the button to confirm the ticket information and implement the payment.

Figure 22. Interface of Ticketing Service

Clicking "audio" button took the user to the scenic spot information interface. Both audio and text guides worked well in Figure 23. In the scenic spot information page, the user could choose different audio guides. Besides, the pictures and texts were changed with the selected audio. For example, if the user chooses audio guide of the Louvre, the picture will change to a symbol of the Louvre, and the text will be same with the audio information.
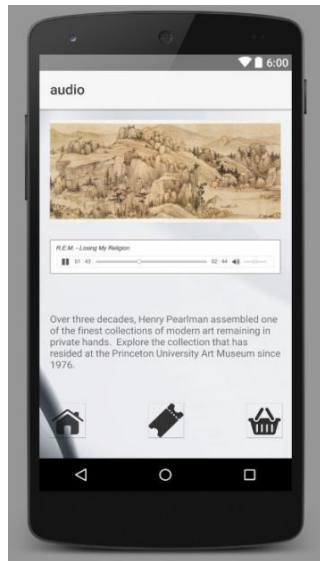
Figure 23. Interface of Scenic Spot Information

Clicking "shop" button, the button looked like a blanket. Every picture worked successfully as shown in Figure 24. In the online shop page, the user was able to select favorite product if he/she was interested in the museum. The products can be pre-ordered by choosing pictures.

Figure 24. Interface of Online Shop

6.4   Exiting the Program

It was same as the real operation, clicking enter backstage button, then clicking exit button on "TravelGuide". So far, the system test was finished as shown in Figure 25.
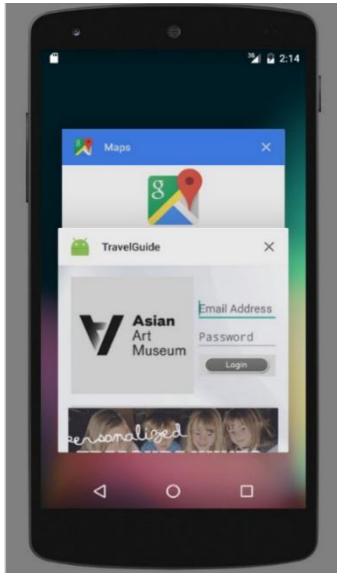

Figure 25. Interface of Exit

In the interface of exit, exiting the application was same with the operation of a real device. The user can hold the application's border and pull to right, then it was successful to exit the application.

6.5   Test Result

The Android AVD was based on Android Studio. Nexus 5 was chosen to be the virtual device, and the testing system was Android 5.1.1. This travel guide application should follow the recent device and operation system. At first step, the application started successfully without any errors. Then, every "onclick" button worked, and the text-typing box was able to type in.

After the home page testing, the page switched to other three pages by clicking each button at bottom. These three interfaces include scenic spot information page, ticketing service page and online shop page. It took a long time to finish the whole test, every function operated successfully. However, there was one

problem during the test, which is the Android AVD's RAM was allocated insufficiently. Therefore, this application has possibility to crash during the operational status.

7   CONCLUSION

Deriving from the objectives of this research, the outcome of the research was development of a mobile travel guide application with added functionalities to an existing application, and quizzes for every part were included as well. The objective of the travel guide application was to develop functions of audio guide, online ticketing sale and online shop service. The aim of the travel guide was to provide the users with a more convenient application to users compared with the traditional travel guide.

The added functions to an existing application were the core focuses of this thesis study. On the Internet, some basic function codes are presented as open source code, which provides convenience to the development. For instance, the audio feature was implemented by using MP3 code. Mostly, regarding the similar applications, the old version of application's implementation had many kinds of issues with scaling the layout or others. Thus the new version which developed this time had to be an integral one.

The results of the questionnaire made a good answer to the research question, and provided useful information to develop the application for museums. It is shown that Android hold a strong user group, so that the application was designed based on Android system. Furthermore, mobile has become a kind of indispensable tool of modern people, and more and more applications are provided for users to choose. To know user requirements may develop the application better.

Within this Bachelor level thesis study, only three added functionalities were designed and developed. However, there is still a wide range of space to improve and develop more functionalities, such as the navigator function which includes Global Positioning System and route navigation. The multiple language choice function may be worked on mobile instead of only on web. The feedback function is able to let users share information and recommend certain museums to other users.

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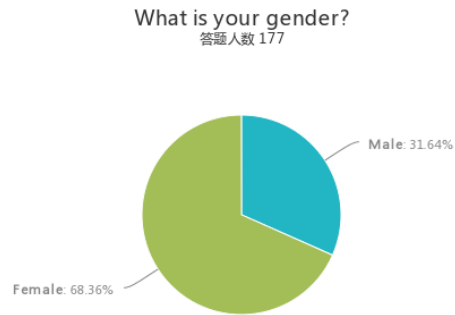
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APPENDICES

Mobile Travel Guide Application Questionnaire

Q1: What is your gender?
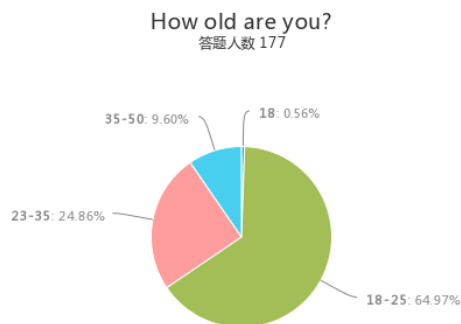

Options	Result
Male	56
Female	121

Number of respondents 177

Q2: How old are you?

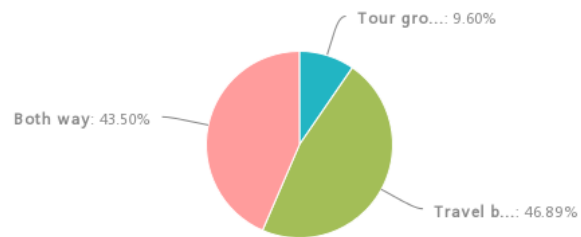| Options	Result
18	1
18-25	115
23-35	44
35-50	17

Number of respondents 177

Q3: Which travel way will you choose?
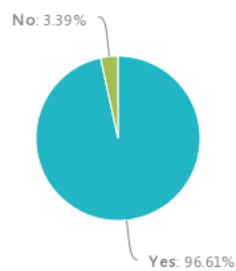
Which travel way will you choose?
答题人数 177

Tour gro...: 9.60%

Both way: 43.50%

Travel b...: 46.89%

Options	Result
Tour group	17
Travel by my self	83
Both way	77

Number of respondents 177
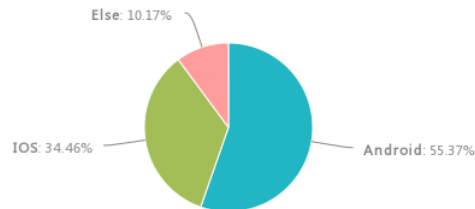
Q4: Do you use smart phone?

Do you use smart phone?
答题人数 177

No: 3.39%

Yes: 96.61%

Options	Result
Yes	171
No	6

Number of respondents 177

Q5: What system is run in your smart phone?

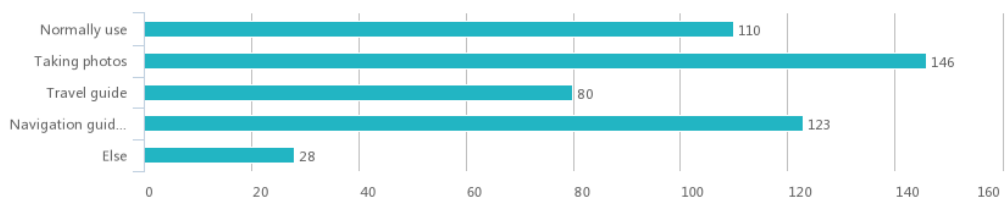| Options	Result
Android	98
IOS	61
Else	18

Number of respondents 177

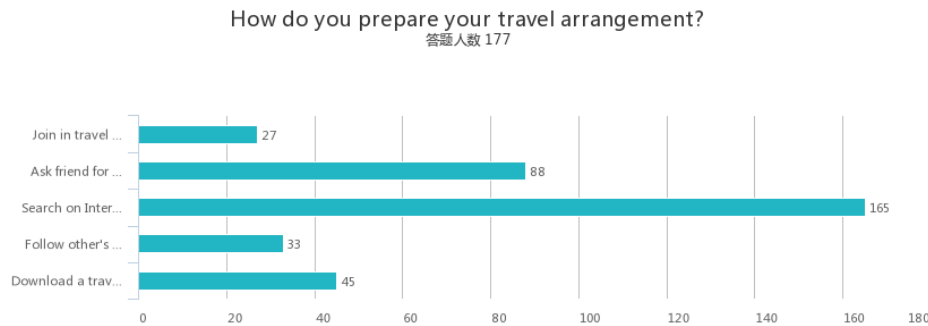Q6: When you are travelling, what functions do you use of your mobile?

Options	Result
Normally use	110
Taking photos	146
Travel guide	80
Navigation guide	123
Else	28

Number of respondents 177

Q7: How do you prepare your travel arrangement?

How do you prepare your travel arrangement?
答题人数 177

Options	Result
Join in travel agency	27
Ask friend for advice	88
Search on Internet	165
Follow other's travel itinerary	33
Download a travel guide APP	45

Number of respondents 177

## Q8: What functions do you usually use of travel guide APP?

What functions do you usually use of travel guide APP?
答题人数 177
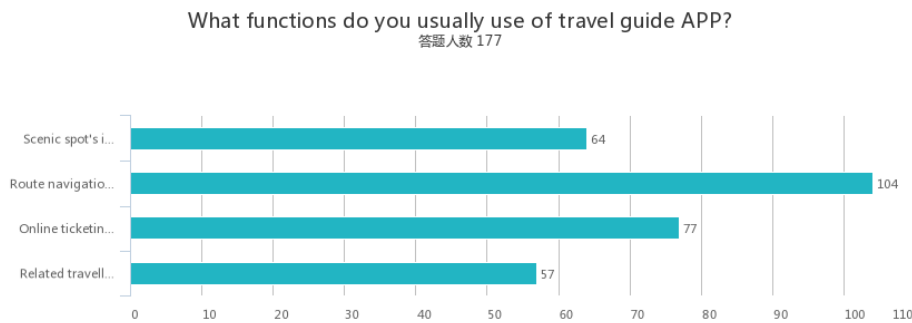
Options	Result
Scenic spot's information	64
Route navigation	104
Online ticketing and online shopping	77
Related travelling feedback	57

Number of respondents 177

Q9: If there is a travel guide APP for you, what functions do you think is necessary?

If there is a travel guide APP for you, what functions do yo
u think is necessary?
答题人数 177
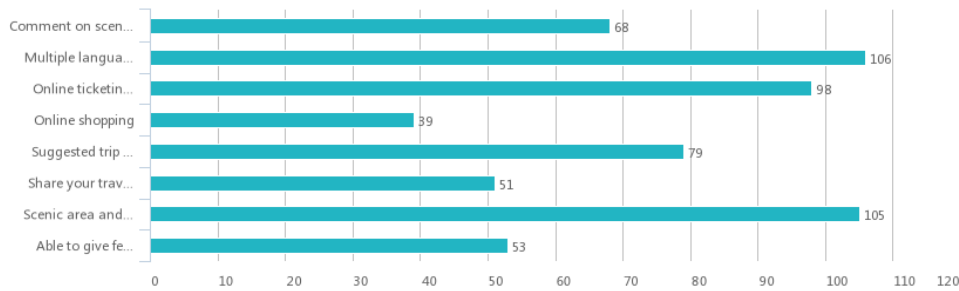
Options	Result
Comment on scenic spots	68
Multiple language choices	106
Online ticketing	98
Online shopping	39
Suggested trip itinerary	79
Share your travel notes	51
Scenic area and surrounding area navigation	105
Able to give feedback of scenic spots	53

Number of respondents 177