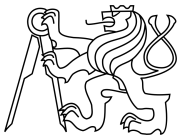
CZECH TECHNICAL UNIVERSITY IN PRAGUE
FACULTY OF INFORMATION TECHNOLOGY



ASSIGNMENT OF BACHELOR'S THESIS

Title:	Development of Android and iOS Mobile Application for Restaurant Chain Support by Using Unity3D Multi-platform Development Tool
Student:	Denis Korchun
Supervisor:	Ing. Pavel Náplava
Study Programme:	Informatics
Study Branch:	Information Systems and Management
Department:	Department of Software Engineering
Validity:	Until the end of summer semester 2015/16

Instructions

1. Describe the ways how to promote a restaurant chain with respect to appropriate mobile application support.
2. Analyze existing mobile applications that were designed for restaurant's customers use.
3. Develop a new application for both iOS 8 and Android 4.4 mobile platforms (use the Unity3D framework) with the following minimal functionality: definition of restaurant branches; functions for each branch: Menu, Table reservation, Gallery, Map & How to Get to the restaurant.
4. Test the developed application and evaluate feedbacks of application users.
5. Evaluate expected application benefits (economic, managerial, technical) and compare them with the development and support costs. Try to evaluate benefits of Unity3D development tool usage, too.
6. Provide a tutorial how to start with business application development in Unity3D.

References

Will be provided by the supervisor.

L.S.

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Prague January 31, 2015

Czech Technical University in Prague
Faculty of Information Technology
Department of Software Engineering

Bachelor's thesis

Development of Android and iOS mobile application for Restaurant Chain support by using Unity3D Multi-platform development tool

Denis Korchun

Supervisor: Ing. Pavel Náplava

12th May 2015

Acknowledgements

I would like to thank Ing. Pavel Náplava for his useful feedback, positive outlook as well as for his strong desire to help create a valuable work. I'd also like to thank my girlfriend and my family for their invaluable support, patience and bright ideas.

Declaration

I hereby declare that the presented thesis is my own work and that I have cited all sources of information in accordance with the Guideline for adhering to ethical principles when elaborating an academic final thesis.

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Faculty of Information Technology

Citation of this thesis

Korchun, Denis. *Development of Android and iOS mobile application for Restaurant Chain support by using Unity3D Multi-platform development tool.* Bachelor's thesis. Czech Technical University in Prague, Faculty of Information Technology, 2015.

Abstrakt

Tato bakalářská práce se zabývá třemi tématy. První část obsahuje přehled způsobů podpory marketingového procesu řetězce restaurací. Druhá část obsahuje popis procesu implementace mobilní aplikace v Unity pro řetězec restaurací a jeho výstupy. Třetí část obsahuje vyhodnocení výsledků vývoje z hlediska dodavatele softwaru a také z pohledu zákazníka. Hlavním výsledkem bude závěr, zdá má smysl vytvářet mobilní business aplikace v Unity nebo ne.

Klíčová slova Unity, mobilní aplikace, business aplikace, crossplatforemní aplikace, restaurace, řetězec restaurací, marketing, CRM

Abstract

This bachelor's thesis focuses on three main topics. The first chapter reviews support of restaurant chain marketing process. The second one contains implementation process of cross-platform mobile application in Unity for restaurant chain as well as demonstrates its outputs. The third chapter provides evaluation of results from both client's and software vendor's perspective. The main output of this work will be a conclusion on whether it makes sense to develop business mobile applications in Unity or not.

Keywords Unity, mobile application, business application, cross-platform, restaurant, restaurant chain, marketing, CRM

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Introduction

Nowadays, restaurant industry is highly competitive. It is not enough to serve delicious food and provide good customer service to stand out from thousands of other places. As the result, restaurants look for other ways to attract and keep customers. One of the most interesting is a mobile application. However, it is often being undervalued. Most of the restaurants which have their own application use inexpensive and limited solutions as well as underestimate the importance of the application requirements analysis.

The most effective way to achieve compromise and develop less expensive application of a good quality is to cut cost of an application by using cross-platform development tool. The Unity platform with its new user interface system seems to be very interesting and reliable. Despite the fact that it is mainly used for game development and is not considered as a tool for creating business applications, several factors suggest that this opportunity is worth exploring. For example, the fact that requirements on applications are increasing as mobile devices' hardware is being continuously improved as well as that business application development is often a specific subset of game development.

The objectives of this bachelor's thesis are to analyze existing application for the restaurant chain, develop new application in Unity for iOS and Android platforms as well as to assess investment of the restaurant chain in mobile application developed in Unity and evaluate development process of business mobile applications in Unity.

The first chapter reviews support of a restaurant chain marketing process. The second one focuses on the implementation process of cross-platform mobile application in Unity. The third chapter provides evaluation of results from both client's and software vendor's perspective.

Chapter 1

Restaurant chain business processes. Marketing process

1.1 Restaurant business processes

The Oxford Dictionary defines restaurant as "a place where people pay to sit and eat meals that are cooked and served on the premises". [1] Of course, there are various types, which are mainly:

- Fast Food,
- Fast Casual,
- Family Style,
- Café or Bistro,
- Food Truck,
- Restaurant Buffet,
- Pop Up Restaurant,
- Fine Dining. [2]

In my work I will focus on the fine dining restaurants, which are more formal and usually more expensive than the other ones. Cambridge Advanced Learners dictionary has the following definition of Fine dining: "a style of eating that usually takes place in expensive restaurants, where especially good food is served to people, often in a formal way".[3]
It is worth noting that in many sources there are special requirements for a place that demands being called "Fine dining restaurant". For example, there should be an interesting menu that offers some unique items. Also, customer service in fine dining restaurant usually includes escorting customers to their

tables, holding a chair for women and explaining menu items without notes, etc.
For every restaurant it is useful to have established support processes such as:

- Purchasing (raw) food,
- Storing (raw) food,
- Cook food,
- Serve the customer,
- Finance management,
- Personnel management,
- Marketing management. [4],[5],[6],[7]

In case of a restaurant chain, among the processes mentioned above, which restaurant manager should be responsible for, it is necessary to define his/her authorities and how the quality of his/her work will be evaluated. A restaurant chain has various advantages over a single restaurant. For example, wider possibilities of loyalty programs, greater restaurant brand awareness, higher probability of returning customer's visit due to existence of different branches, given that high quality service is being constantly maintained in each branch. It is obviously harder to manage a restaurant chain and to take advantage of one. My work will be dedicated to the restaurant chain marketing process support.

There is a wide range of restaurant marketing methods. They are mainly based on constant monitoring of customers' experience and needs, providing care about them through every communication channel client could be reached.

Like every other business, restaurant needs to have its own style that could distinguish it from the other ones. It usually includes a restaurant logo that in some way defines restaurant's color pattern, which could used in interior and sometimes even in meals.

1.1.1 Marketing process

There are many marketing tools that a restaurant could use in order to reach customers.
The first one is a functional, intuitive and responsive website that will provide at least basic information that is useful for both potential and returning customers:

- menu list,

- detailed directions for both public and private transport,
- table booking - it is good to have functional reservation system that includes:
  - Internet booking with confirmation via email,
  - booking by phone - it is important to ensure reservation numbers won't be busy all the time,
- picture gallery.

It is equally important to make sure customers are able to find your website. The POS Sector website gives restaurateurs the following advice: "Your site must be properly optimized and that means it must meet certain criteria according to which search engines are ranking pages as interesting and offering them as search results". [8]

The second one is social media marketing. Communication channels, such as Facebook, Twitter, Google and Pinterest, should be used to inform various types of customers about what is happening in the restaurant as well as to receive useful customers' feedback in order to improve business and increase profits. Interaction is a keystone in this question and there are lots of ways to do it, for example, by providing special offers for social media fans, setting different surveys, announcing competition with tempting prizes for winners and so forth. [8]

The third method is to have a YouTube channel. [8] As well as for every other communication channel, there should be a person responsible for interesting and up-to-date content, as well as for attracting visitors. In my opinion, a restaurant brand could be negatively impacted in case that any of its official communication channels is not maintained or does not correspond to its status.

The fourth is a mobile application: according to USA market statistics of gathered in 2012 by "xAd" and "telmetrics" companies, 75% of the smartphone users access restaurant information on the go. [9] Taking into account the fact that the most popular applications used by restaurant mobile searchers are multi-purpose online review aggregators like Yelp, Zomato and Tripadvisor, it is important for a restaurant chain to stand out from others in this field. It could be done in the following ways, which are not mutually exclusive:

- Providing exceptional service and gaining highest ratings on online review aggregators as a result. Use of the copywriters' services is not a solution in the long-term perspective for restaurants which are below average level, [10],[11],[12]
- Creating an own application for restaurant chain. This solution is oriented on the returning customers, which generate up to 51% of revenue

in fine-dining restaurants. Application may be a decisive factor for customers when it comes to restaurant selection. [13]

In average, people spend 35% more time using their smartphones compared to using PCs. [14] Moreover, that's the only device we have nearby during our whole active day. With fast enough mobile internet it became our companion which provides comfort access to information we need. A mobile application could also support marketing process in different ways:

- Build returning customers' database - provide auto-filling during the table reservation in return for customer's personal data.
- Restaurant email marketing,
- Increase customers' loyalty - for example:
  - mobile application will allow users to use their personal QR codes instead of showing plastic club card to personnel,
  - provide personal special offers. [8]

Thus, I consider that it is one of the most powerful marketing strategies at the moment and it will only gain popularity.

However, there is no marketing strategy that could be a solution for a business, in my case, the restaurant chain, whose things are not going well nor management is trying hard enough to find out how to make the it better. [12],[15],[16]

In my work I will focus on the mobile application for restaurant chain. As well as other marketing strategies, it should meet the customers' expectations in terms of restaurant's status. If it is a fine-dining restaurant with a high-quality service, the application should be of a high quality, too. In my opinion, ideally, application, as well as a restaurant, should provide some unique experience for customer and make him craving the return. The content needs to be managed and updated on weekly basis. I will analyze existing applications from the users' point of view, describe restaurant chain's customers, design the new one based on their possible needs and implement it.

According to the statistics, market shares of smartphones' operation systems are the following:

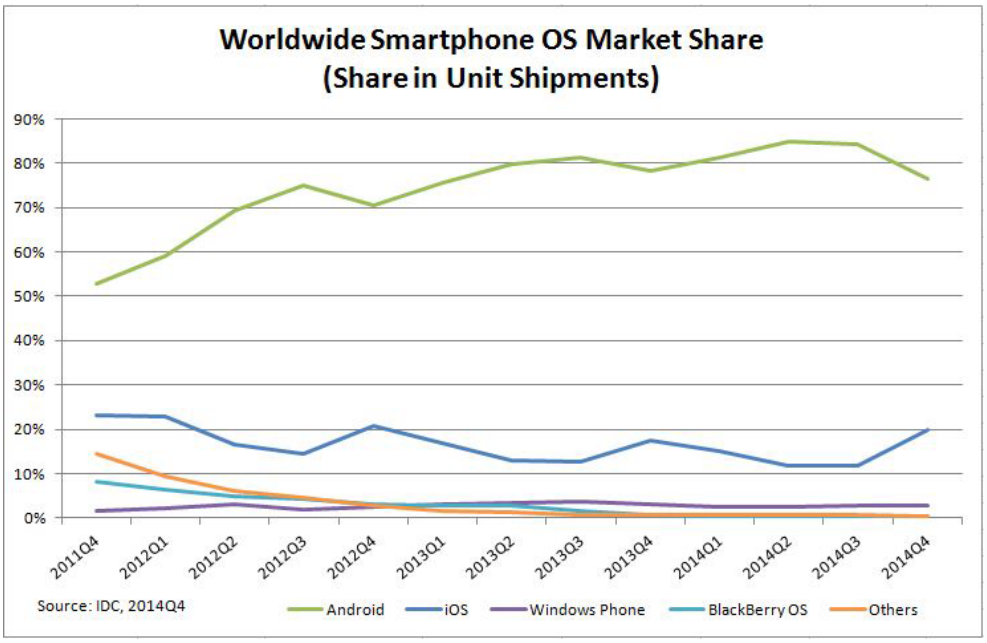

Figure 1.1: Worldwide smartphone OS market share, 2011-2014.
Source: [17]

It means that when we consider developing an application for the public use, it's not enough to develop it for one platform, especially when it comes to the group of returning customers of a fine-dining restaurant chain. The statistics will differ: probably, there will be more than 20% of iOS devices because ones are usually bought by people from upper than middle social class who are likely to visit fine-dining restaurants, which are usually more expensive than other ones. [18]

1.2 Existing mobile applications

This section focuses on the main problems of existing application for . The main conclusions below were obtained during the heuristic evaluation which was made by three students including me as a part of the User Interface Design subject at FIT CTU as well as my personal deeper evaluation of the application. [19],[20]

1.2.1 Grosseto mobile application

On the figure below the main screen of Grosseto mobile application is shown.

Figure 1.2: Main screen of Grosseto restaurant chain mobile application. Source: [21]

The problem of the main screen is that there are too many elements on it. The user gets lost and has no idea what he should do nor can quickly find the way to fulfill the purpose of his/her visit. The area that includes two images is actually a button which will take user to restaurant branch menu. As a user, it took me three visits of application to figure out that I could take a look at other branches using a swipe gesture on the main screen. I found very frustrating that this is the only simple way to do it. The red elements at the bottom have poor color combination with dark-brown background and there are too many elements.

- For example, there are actually two links to the "Aktuality" - "News" screen - using the button at the bottom and clicking the small button in the top right corner.

- The button that brings user to Facebook inside of the restaurant chain application doesn't seem to be among most used features of an application.

The second screen I would like to show is the one which appears after clicking the "More" button at the bottom-right corner:

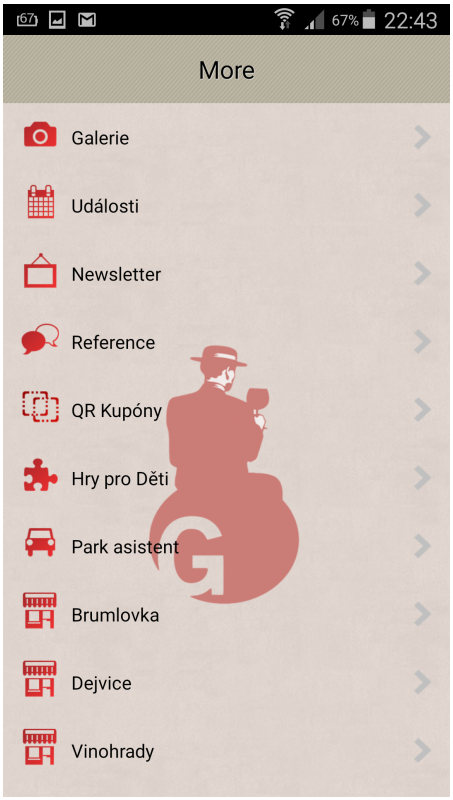

Figure 1.3: "More" section of Grosseto mobile application.
Source: [21]

The same problem persists here - there are too many menu elements. In my opinion, there is no need in th part of an application. Let's take a look at the figure above from top to bottom.

- "Galerie" - "Gallery", in my opinion, should be present in the details of restaurant branch. Unfortunately, it isn't, and could be only accessed through the "More" section shown on figure above. However, after clicking on "Gallery" button, the list of restaurants is shown. This part doesn't seem to be evaluated by anyone before implementing it.
- "Události" - "News" section is empty and looks poorly. For me as a user it is confusing and makes me want to leave this application.
- Button that stand for restaurants "Brumlovka", "Dejvice", "Vinohrady" should not be here if they were better accessible from the main screen.
- "Newsletter" - registration for a newsletter - should have been substituted with registration for a client card and offer something in return for personal data provided by user.

- "Reference" section which should have contained comments from customers is almost empty. There are only two comments for almost a year. There is a possibility of leaving a comment almost on every screen of the application which, in most cases, is a nonsense. For example, why would a user want to comment the terms of usage of gift cards?
- "QR kupóny" - "QR coupons" section - see Figure 1.4.
- "Park asistent" - "Park assistant" section is unusable - I haven't figured out how to use it nor anyone from four people I asked. An external link to Google navigation from my location to the place could be more helpful.

The fact that can really annoy user is when the sections that should have made application interactive and helpful turn out as unusable, so that user gets the feeling he can't rely on application. This could negatively impact the restaurant brand. Let's take a look at the "QR coupons" section:

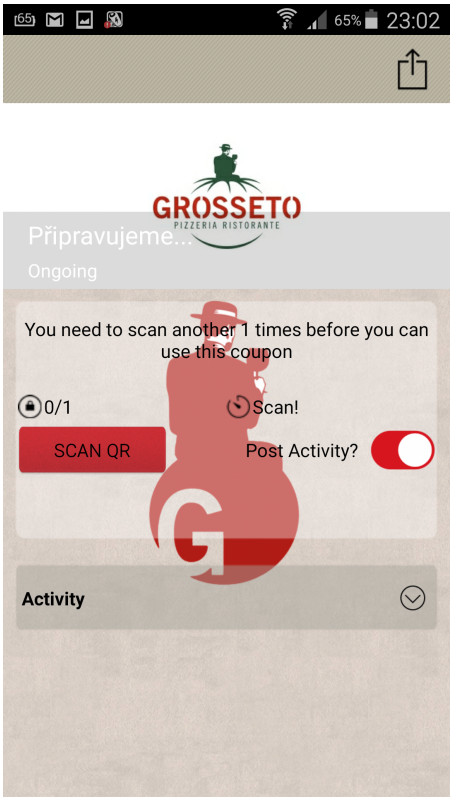

Figure 1.4: "QR coupons" section of Grosseto mobile application. Source: [21]

The only way for user to determine what is happening in this section is to notice nearly unreadable white label "Ongoing" on the left side of "Grosseto" logo at the top. User doesn't know what QR code to scan, doesn't necessarily know how to do it, why to do it nor what he/she will get in return. Also, there are two restaurant chain's brands on one screen. In my opinion, screens like this could negatively impact the restaurant brand - the fact that application was launched almost a year ago suggests that this section will never be finished.

Figure 1.5: "Gift vouchers" section of Grosseto mobile application. Source: [21]

This section - "Darkové vouchery" - "Gift vouchers", in my opinion, is relatively useless - instead of motivating customer to buy the gift voucher there are their terms of use which most people simply don't read. Sections like this make the application look overflowed.

The application described above, as well as most of the applications for restaurants in Prague I have found, was made using so-called Application Builders. This information was obtained through the proxy server Charles that allows to intercept communication of the mobile application and server. All of them were communicating with servers that were hosted on the application builder's domain, for example, `www.biznessapps.com`. The applications made this way are extremely cheap - often, they cost less than 50'000 CZK and easy to create.
There are, however, several major drawbacks that prevent customers to use applications created this way, for example:

- usually, too many features,
- various defects all around the application, such as:

  - screen rotation results in stretched restaurant logo in the background,
  - application was made for one platform (in this case, iOS), and runs slow on other (Android) - when swiping different restaurants on the main screen.

- unfinished functionalities - probably, client demands too many features without conducting any analysis,
- no possibility of searching the products (except those which were built in the application) - no possibility of updating the built-in ones,
- no possibility of providing the application in different languages, or it is too expensive, because in 4 applications made this way I found there were only poor attempts of providing it in the English language,
- looks and feels like many other applications created this way, lacks individuality.

For business, in my case, restaurant chain, those applications lack

- everything that concerns clients - personal information collection, motivation for clients to provide their personal data, future possibilities of connecting it with POS restaurant terminal and CRM system. Considering the fact that application is targeted on returning customers, this possibility should be presented.

Those drawbacks are caused by the fact that all useful content application provides is shown in the Web views - web pages of business' website inside an application. Also, it isn't the most reliable solution - changing the website may cause the malfunction of application.

However, the application created this way may be sufficient for smaller business, provided that the analysis of required functionality as well as testing is conducted. They offer important feature compared to web pages for mobile devices - push notifications, which allow to notify all users even when the application is turned off.

1.2.2 Ambiente mobile application

I would like to show a part of another application, where I liked the idea that every restaurant branch is shown on the main page:

Figure 1.6: Main screen of Ambiente mobile application. Source: [22]

As a user, I like the fact that I don't need to swipe anywhere and have every branch of the restaurant chain shown on the main screen. However, I found very confusing that there are different images right near each other. Also, they are rather hard to remember and have nothing in them that could help user identify each branch.

It looks like the application was made by using Android SDK for Android and iOS SDK for iOS. In restaurant detail sections, there are directions to the restaurant, menu and contact. Based on my experience in mobile software development company, I assume that despite the fact that application is simple, it cost in range of 350'000-550'000 CZK for both iOS and Android platforms.

1.3 New application definition

Grosseto restaurant chain required an application, but evidently wasn't ready to spend more than 300'000 CZK on it.

I consider the main requirements for an application are following:

- it should be simple,
- it should be developed for two or three mobile platforms,

- it should cost less than the native one,
- it should have something unique in it,
- it should support marketing process of restaurant and increase customers' loyalty.

More detailed requirements are presented at the beginning of the next chapter. The best way to reduce cost of the application developed for several mobile platforms is to use cross-platform development tool. The most common of them are:

- PhoneGap,
- Titanium,
- Xamarin,
- Unity.

PhoneGap and Titanium tools are less complex. They are using web technologies and Javascript. Based on my own experience, I consider that these technologies are not the most reliable ones.

Xamarin seems more complex but I know from developers that it lacks customer support and still has many issues in it. Also, Xamarin is oriented on native UI design, which means that for each platform I would have to implement its own look. [23]

Unity platform is mostly used for mobile game development, but in autumn 2014, a new user interface system was released and it looks very promising. Unity allows developers easily design custom user interface, that is, to effectively design unique user experience. Unity applications could run on 4 different mobile platforms. Moreover, Unity offers wide range of animation and gamification opportunities. [24],[25],[26]

I decided to use Unity platform to get acquainted with development in it, with custom UI design of mobile application and programming in C#.

The next chapter includes requirements analysis, mobile application implementation process and its outputs.

Chapter 2

Requirements analysis. Implementation

Unfortunately, the attempt of establishing contact with Grosseto restaurant chain was not successful. Thus, all requirements below are based on several potential application users' opinion, analysis of existing application given in previous chapter and consultations with CRM specialist.

2.1 Requirements

In my opinion, there are two perspectives on mobile application that should be taken into consideration and both be well-thought out in case of restaurant chain:

- user perspective,
- business perspective.

In the new application, I will try to eliminate drawbacks of existing application as well as add features that could be useful.

2.1.1 User perspective

The main restaurant chain client group is in age of 25-32 years. The main social class is middle and upper middle class - based on own experience visiting restaurant as well as on restaurant price level. The main audience would probably welcome attentiveness of service that would, for example, save clients' time spent on placing the order and develop loyalty program that will be easy to participate in. Restaurant chain is mainly visited by two people - based on own experience. Average amount spent on dinner for two people is 900 CZK. [19],[27],[28]

From the user's perspective, I consider the following features and properties as a must:

- Be simple. Nowadays, we are overloaded with information, most of which is useless for us. I found support for my thoughts regarding this question in various articles, as well as I know from my own experience. Nick Bilton, the author and New York Times journalist suggests that usually overload is an interface problem. For example, I use only 3 or 4 mobile applications on the regular basis and the main reason why I stop using one is that there is too much information or features in it. [29],[30]

- Thus, let application to carry a simple mission: help and motivate users to visit the Grosseto restaurant chain.
  The following mistakes found in existing applications should be avoided:

  - use of too rich logos on the main screen that are difficult to memorize,
  - place too many elements in each section,
  - overwhelm the application with features user doesn't need,
  - add functionality that is not going to be finished in the nearest future,
  - add features that are unusable.

- There should be an easy access for table reservation. The user should get help with the routine, such as filling in his name or a member card number.

- Easy access for the directions to restaurant chain branches should be provided.

- Information about the menus of restaurants should be provided. Embedded web pages should be avoided.

- User should benefit from providing his/her personal data.

2.1.2 Business perspective

From the business perspective, I consider application should effectively collect customers' personal data for later analysis by other systems and applications. Later, analyzed information could be used in targeted marketing offers. As a result, customers' loyalty could be increased, which could lead to revenue increase.

2.2 Implementation

The application designed and implemented as a part of this bachelor thesis was created by myself for educational purposes. It is a pilot version which does not solve possible connectivity issues that are typical for mobile devices nor contain any pop-up windows or loading indicators.

In addition to application functionality described in the bachelor thesis assignment, I have added a client zone section with registration and log in features.

2.2.1 Database

I consider the best way to start with design of an application is to analyze data it will require. In this work, MS SQL Server technology was used for designing the application database.

After consultation with database expert, I decided to make my database schema reusable. For example, my database allows storing restaurant branch menu list in as many languages as it is required using a table called Dictionary (for details, see figure: Database schema for the new mobile application). Based on the information I found about Grosseto restaurant chain, I have also decided to allow each restaurant branch to:

- have independent menu list administration
  - this will allow each restaurant to have unique dishes which will motivate customers to visit different restaurant branches rather than visiting the same one
- choose various count of levels in the menu list
  - for example, in wine restaurant branch, there are much less categories of products it provides compared to the fine-dining one.

This was made possible thanks to the Hierarchical Data Model, which is widely used, for example, in electronic shops where it's not defined how many levels of depth each menu section could have. [31]

The example of hierarchical data model usage is presented on figure below.

	ID	ParentID	OrganizationID	CatalogLevelName
16	596E5E29-C409-4266-A360-84E704DB5E05	1b2590e1-293d-4a0b-b504-86e7c9fb8733	D27F92B8-7C6C-4DD4-9B5B-601973EFD80D	Actuality
17	1B2590E1-293D-4A0B-B504-86E7C9FB8733	00000000-0000-0000-0000-000000000000	D27F92B8-7C6C-4DD4-9B5B-601973EFD80D	Menu
18	F9E964A4-DADC-48AC-BA76-8917CF1CA81E	33a38ef4-b0c9-46f0-abee-5e315e1137ef	D27F92B8-7C6C-4DD4-9B5B-601973EFD80D	Basilicata
19	F68BDE43-181E-4D4B-B8DC-89B4E428EA3D	00000000-0000-0000-0000-000000000000	7C680720-4377-4036-8A64-A2900364D6F8	Gourmet baskets

Figure 2.1: The hierarchical data model usage in database for developed mobile application

The row number 17 on the figure above stands for the first (root) level of depth, thus, has a "zero" ParentID. In all other cases, one's ParentID matches another row's ID - for example, 16-th row's ParentID matches the 17-th ID. That means that menu level for which the 16-th row stands is a child of 17-th row's menu level. I used GUID data type for representing identifiers in the database.

The database schema is provided below.

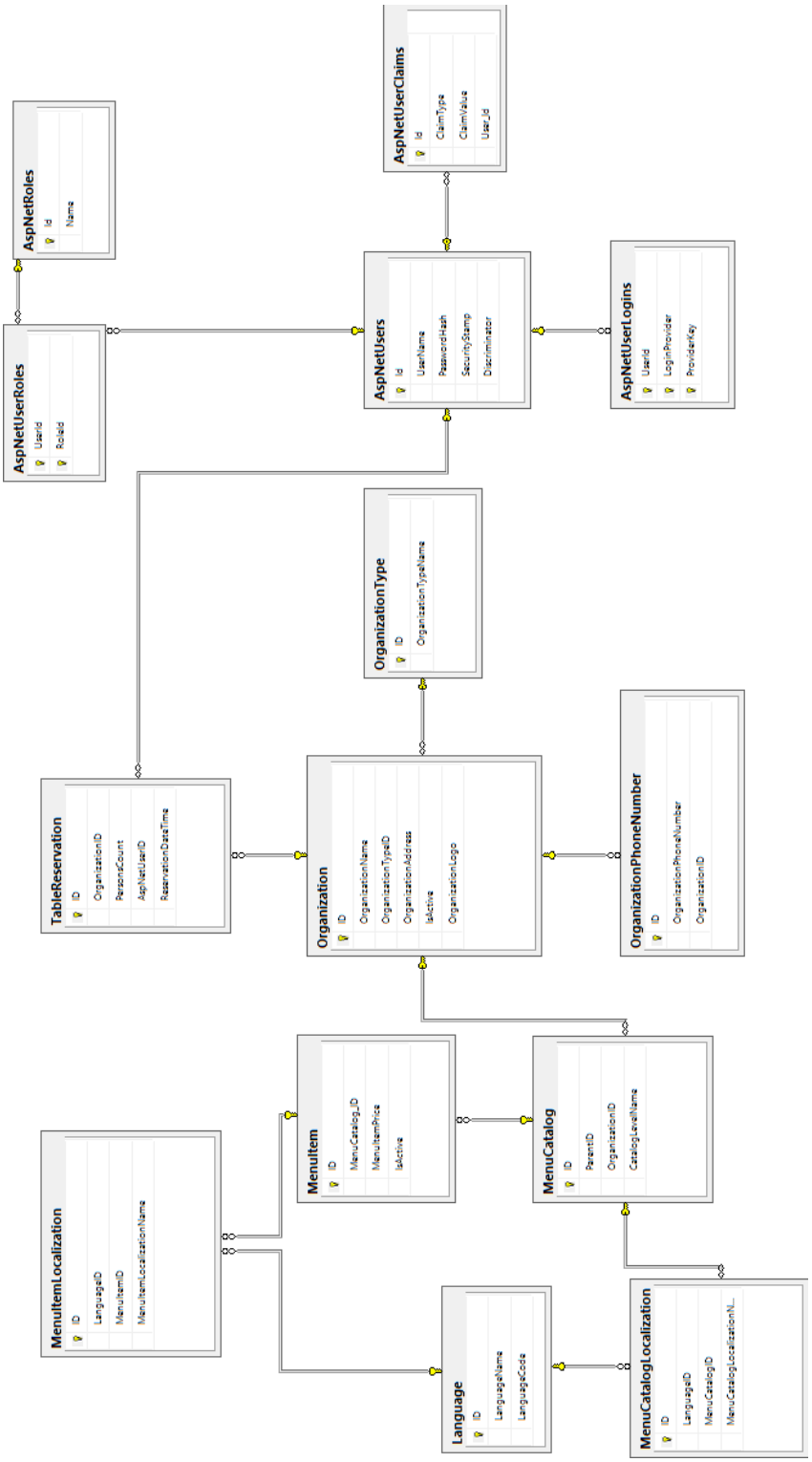

Figure 2.2: Database schema for the new mobile application

The ASP.NET MVC user template was used in order to securely store users' passwords.

2.2.2 Backend

I used the MS ASP.NET MVC and Web API technologies for implementing the server part of the application. I also used Entity Framework as an ORM tool. I was using LINQ component which showed itself as very intuitive and easy to use.

Communication between phone application and server takes place through RESTful API. I have chosen to use REST architecture style because of its simplicity. [32]

The information is transferred in JSON objects. The most important methods I have implemented are presented below.

1. Method that provides a list of restaurant chain branches with the details needed by mobile application. It is available from `http://grosseto.somee.com/api/organization`. Following two figures below demonstrate JSON object representation of information about restaurant chain branch and implementation of server method that returns the list of restaurant branches.


```
"ID":"d27f92b8-7c6c-4dd4-9b5b-601973efd80d",
"OrganizationName":"Vinohrady",
"OrganizationTypeName":"Restaurant",
"OrganizationLogo":null
```


Figure 2.3: JSON representation of information about branch

```
// GET api/Organization
0 references
public IQueryable GetOrganizations()
{
    var organizations = db.Organizations.Select(x => new {x.ID, x.OrganizationName,
        x.OrganizationType.OrganizationTypeName, x.OrganizationLogo } );
    return organizations;
}
```

Figure 2.4: Controller method implementation

2. Method that provides information about levels of menu list for required restaurant and language. It is available from http://grosseto.somee.com/api/organization/{restaurant branch id}/{language code - "en" or "cz"} /menucatalog, where text in brackets is parameter. Following two figures below demonstrate JSON object representation of restaurant menu level and implementation of method on server side that

returns the list of menu levels for restaurant branch in required language.


```
"ID":"596e5e29-c409-4266-a360-84e704db5e05",
"ParentID":"1b2590e1-293d-4a0b-b504-86e7c9fb8733",
"MenuCatalogLocalizationName":"Actuality"
```


Figure 2.5: JSON representation of information about menu level

```
[Route("api/organization/{OrganizationId}/{LanguageCode}/MenuCatalog")]
0 references
public IQueryable GetMenuCatalogByOrganization(Guid organizationId, string languageCode)
{

        var mc = from o in db.Organizations
            join c in db.MenuCatalogs on o.ID equals c.OrganizationID
            join l in db.MenuCatalogLocalizations on c.ID equals l.MenuCatalogID
            join lang in db.Languages on l.LanguageID equals lang.ID
            where o.ID == organizationId && lang.LanguageCode == languageCode
            select
                new
                {
                    c.ID,
                    ParentID = c.ParentID.Trim(),
                    MenuCatalogLocalizationName = l.MenuCatalogLocalizationName.Trim()
                };
        return mc.OrderBy(x => x.MenuCatalogLocalizationName);

}
```

Figure 2.6: Controller method implementation

3. Method that provides information about products in menu list (which have their representation in the menucatalog method's output as the last levels, i.e. levels that don't have children) for required restaurant and language. It is available from http://grosseto.somee .com/api/organization/{restaurant branch id}/{language code - "en" or "cz"}/menuitem, where text in brackets is parameter. The implementation is analogous to the "menucatalog" method
4. Method that ensures registration of new users.
5. Method that ensures logging in process of users.
6. Method that ensures writing table reservation to database.

Backend application runs on the free hosting and its methods are available through web links mentioned above. However, due to the fact it is free, it may take up to 30 seconds in order for my web API to respond when it is being requested for the first time during the day.

2.2.3 Frontend

I have tried to develop frontend taking into consideration mistakes made in the existing applications analyzed in first chapter of my thesis.

The main screen, as I mentioned above, should be simple and clear, motivating users to take an action. I suppose I have managed to achieve this. Main screen section is shown on the figure below.

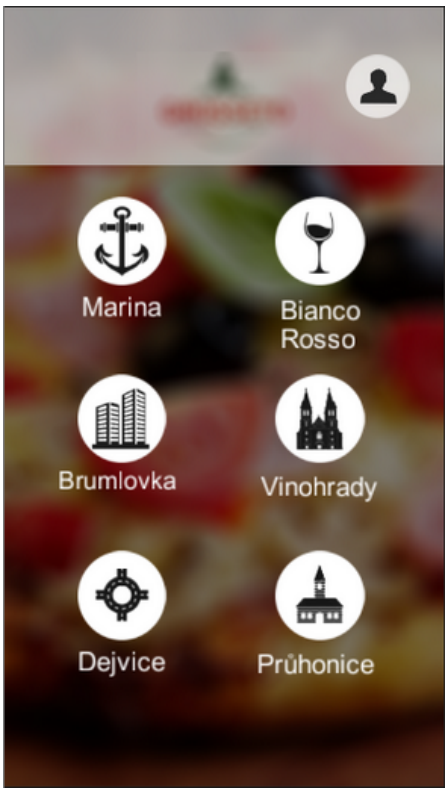

Figure 2.7: Main screen section of the developed application.
Images used: [33], [34]

Each icon means some memorable or well-known place that is situated near each restaurant branch, except Bianco Rosso, which is a part of Brumlovka restaurant. I tried to make icons as simple as possible.

For example, the well-known "Kulaťák" roundabout was chosen as an icon for Dejvice restaurant because it is situated nearby. Icon that reminds Church of St. Ludmila, situated in front of Vinohrady restaurant branch, stands for Vinohrady. Skyscraper icon stands for Brumlovka because this restaurant is situated in the business center area not far from Budějovická metro station.

The icon in the top right corner redirects user to client zone, which is demonstrated on the figure below.

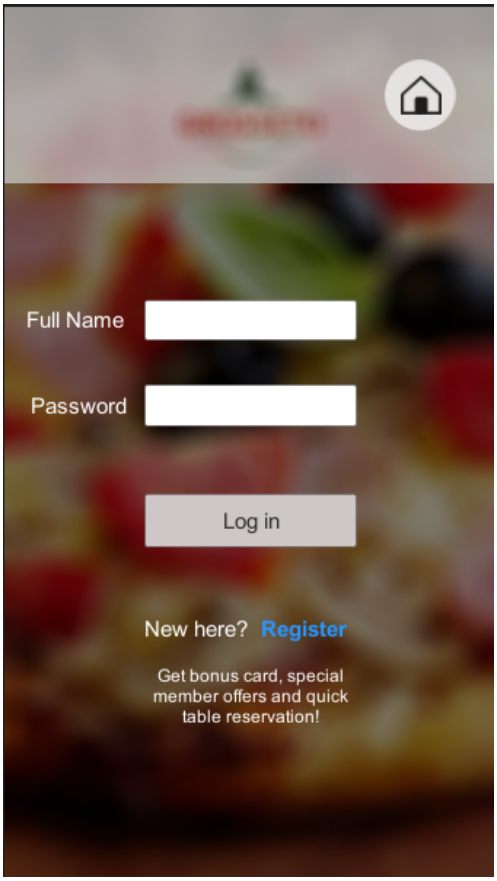

Figure 2.8: Log In section of the developed application. Image used: [34]

The figure above demonstrates Log In section in case user is not logged in. The text written under "Log in" button helps user to make the decision on registration, explaining him/her what one gets in return for providing his/her personal data. The blue "Register" button provides easy access to registration section.

After clicking "Log in" button, the information from fields is sent to server, where log in method is called. If user exists, server returns response "200 OK" and session token. This log in section, as well as the registration section, could be supplemented in future by the following features:

- facebook log in and registration,
- additional personal information to fill during the registration process
  - may be very useful for future data analysis: more accurate targeted offers could cause further customers' loyalty increase

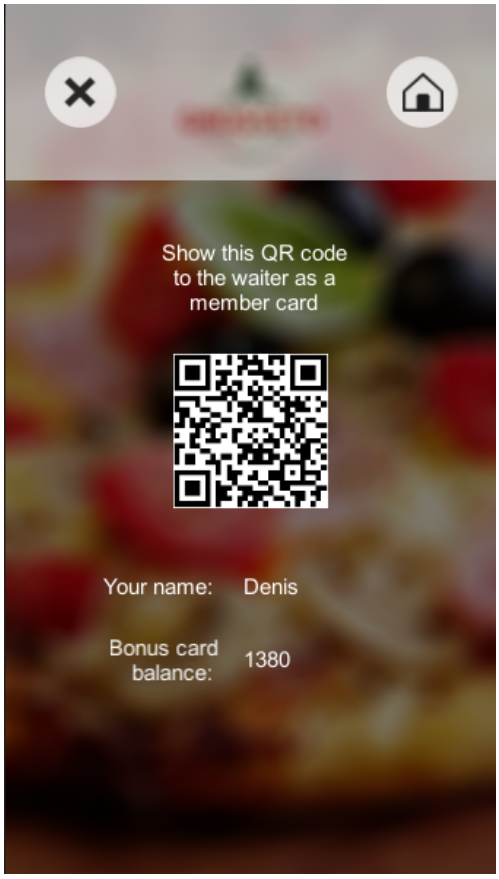

Figure 2.9: Client zone section of the developed application.
Image used: [34]

After user logs in, he/she gets redirected to the section demonstrated on the figure above. His/her personal QR code is generated by 3rd party service and is shown in the client zone. User's log in information is persisted on the device until he/she manually logs off. [35]

The QR code serves as a member card for logged in users so they don't need to carry plastic one in order to identify themselves and earn loyalty program points. Text above QR code explains user how to use it. Button at the top left corner stands for a log off action. Button at the top right corner redirects user to the main screen.

In future, the application for waiters should be considered in order to scan customers' QR codes and identify them. After QR code is scanned, customer's favorite dishes and other useful information could be shown on waiter's device in order to allow personnel provide personal customer care.

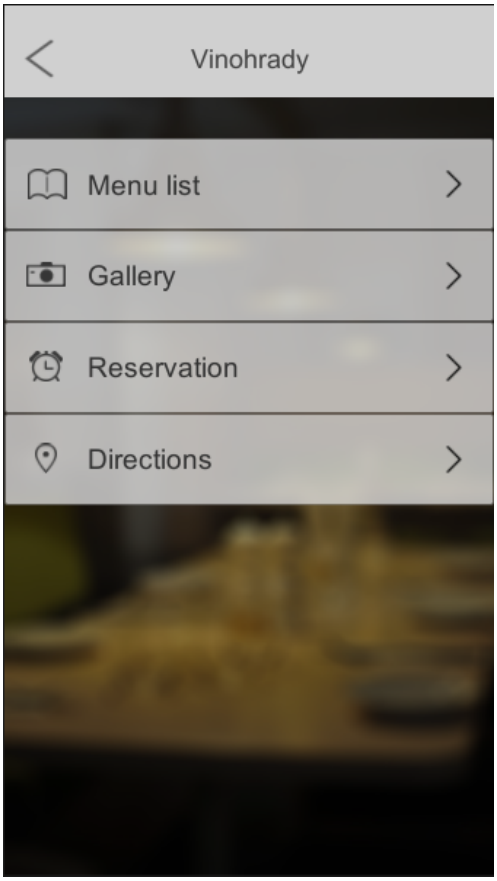

Figure 2.10: Restaurant details section of the developed application. Image used: [36]

Figure above demonstrates details for restaurant branch which are shown after clicking on any restaurant icon button on the main screen. In this case, details for Vinohrady restaurant are shown.

Icons on the left side of each menu item help user navigate. The presence of each feature was discussed with several potential users.

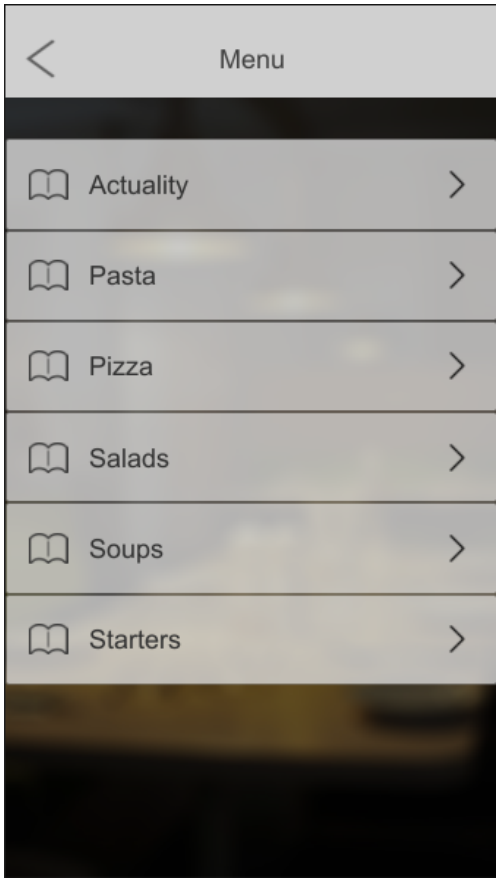

Figure 2.11: Menu card section of the developed application.
Image used: [36]

Figure above demonstrates first level of restaurant menu card section. These rows, as well as all further levels of menu card list, are generated based on the contents of "MenuCategory" table for each level, except the last one, where additional information is obtained from "MenuItem" table.

Stack data type used for the implementation of this section allows restaurants to have variable count of levels in menu card.

I used the LitJSON library in order to deserialize information (received in JSON format) regarding each restaurant branch and store it directly to the containers of appropriate object data type. [37]

In future versions of the application, icon on the left side of each menu card row could be replaced with specific icon for each category. Adding search feature should be considered, too, although it could lead to loss of application's simplicity.

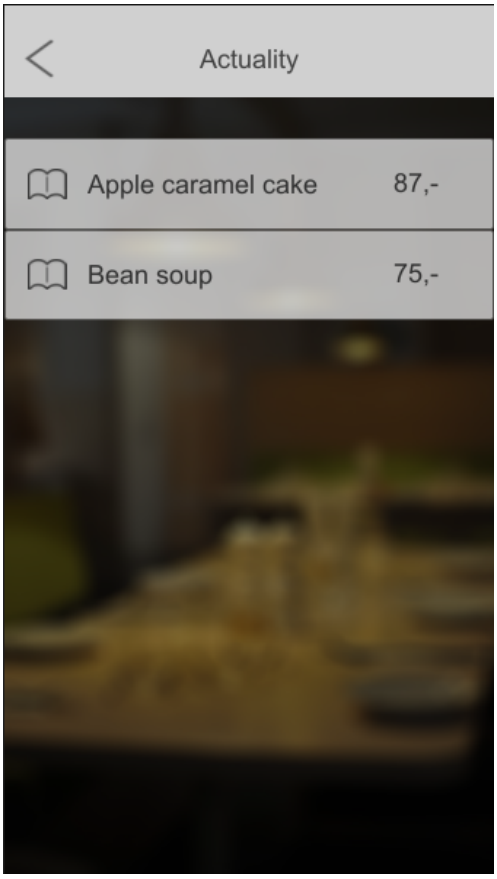

Figure 2.12: Menu - dishes section of the developed application.
Image used: [36]

On the figure above, the information obtained from database table "MenuItem" is combined with last level of "MenuCategory" table in order to display additional information - price of dish.
The following improvement could be added in future versions:

- details for each dish shown after clicking the row, which will include
  - photo,
  - weight,
  - allergens,
  - calories.

Figure 2.13: Restaurant gallery section of the developed application. Images used from: [38]

The gallery section is presented on the figure above. The gallery list above is scrollable. After clicking on a photo, its enlarged version is displayed. The animation was added for the process of opening and closing photo in a full-screen mode.

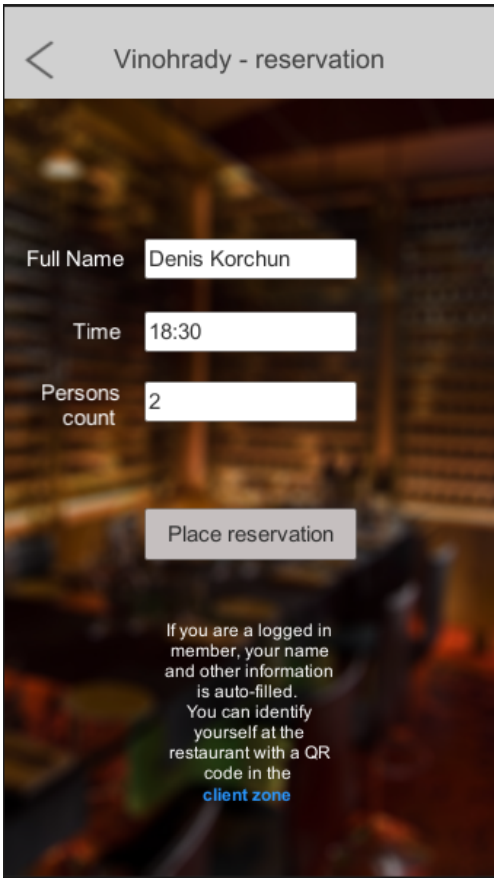

Figure 2.14: Restaurant table reservation section of the developed application. Image used: [39]

Figure above demonstrates reservation section, which is presented in every restaurant branch details menu.

The customer's name here is auto-filled in case he/she is logged in. The text under the "Place reservation" button motivates user to log in/register. The blue button below redirects user to the log in/client zone section

After clicking the "Place reservation" button, filled information is sent to server where it is written to database. This information, as well as users' personal data, could be used for targeted marketing after mobile application database will be connected with POS and CRM system. That is, it will be possible for restaurant chain to:

- send personalized messages in form of push notifications with a discount/special offer when client stops visiting restaurant chain,
- suggest returning customer a dish he likes. This could be possible thanks to combination of systems above and a mobile application for waiters, which could be an example of excellent customer service,

- invite customers to restaurant branches where they have never been before,
- explore new ways of using clients' personal data in order to increase their loyalty and provide exceptional customer service.

In future versions of an application, the following elements could be added in order to improve user experience:

- time picker for time of reservation instead of a text field,
- number picker for person count instead of a text field,

I haven't included those elements because Unity does not have any embedded pickers for mobile applications. I have found native and custom pickers for both Android and iOS OS's in form of 3rd party solutions, but haven't tested them yet. For more information, please see the next chapter. [40]

Figure 2.15: Restaurant directions section of the developed application. Images used: [41], [42]

On the figure above, the "Directions" section for Vinohrady restaurant branch is presented.

Map above the text is a static picture. Together with address and word directions, it should be enough for most of the returning customers to find the restaurant. I decided not to embed map into the application to keep it simple. The button under address redirects user, depending on his/her mobile OS to Google maps - for Android users or to Apple maps - for iOS users. Position of the restaurant will be preset.

In future versions of the application, a static text that stands for restaurant's phone number could be replaced with a button for calling it.

The next chapter includes UI testing results of developed application, comparison between development in Unity and native SDK's as well as economic assessment of restaurant chain's investment in mobile application developed in Unity.

Chapter 3

Results

3.1 Experience with Unity

First of all, I'd like to describe my impressions about using Unity3D. When I was starting to usit new Unity UI, its basic aspects seemed too hard and nonintuitive. As I studied materials and gained basic experience, it became easier for me to orientate in Unity. I started noticing interesting features of development in it that I haven't seen in any other platform, for example:

- developer is forced to use the well-known decoupling design pattern called component, which seems very intuitive to me. The high quality of its realization makes Unity game engine stand out from other development platforms,
- truly good combination of graphical and code representation of developed application.

After I got acquainted with Unity basics, it became easy for me to finish the rest of the application. Also, Unity helped me to get deeper understanding of mobile application development.

3.2 Testing

As it comes to the pilot version of an application, I have chosen to execute only manual UI tests and evaluate users' reviews on the application.

Users' feedback

Each user was familiar with existing Grosseto mobile application as well as was warned about the fact that my application is a pilot version. Reviews were provided by users during personal meetings where they opened my application for the first time. In total, eight persons were asked - two of them were iOS

users and six had Android phones. Users tested the application on Samsung Galaxy S4, Samsung Galaxy S5, Asus ZenFone 5, iPhone 5s and iPhone 6. Their age was primarily 25-35. Results and outputs are given below:

- reviews regarding existing Grosseto application:
  - 6 of 8 persons would not want to use it on a regular basis,
  - 7 of 8 persons found application overcrowded,
- all interviewees liked the main screen,
  - 3 of 3 Grosseto returning customers understood what each icon on the main screen means,
- 5 of 8 persons said they would appreciate additional UI elements like time picker for setting reservation time,
- 7 of 8 persons would like to use the new application.

Though most of the users were involved in application UI design or at least were aware of its future design, reviews may not be as objective as they could be.

UI testing

Manual UI testing was conducted on Samsung Galaxy S4 devices with Android 4.4 and Android 5.0 OS's as well as on iPhone 5s with iOS 8.3 OS.

During it, a problem with keyboard showing was revealed on Android platform. After user clicks on the input field and the keyboard is shown, the screen of an application is moved to the top and becomes cut. However, in another application example, which was implemented on older version of Unity, the problem was not encountered. Another issue is that when one input field is selected, the other one shows as a blank field. After hiding the keyboard input field value is shown again. The other problem is that after adding the animation to gallery section, size of an application increased from 24 MB to 45 MB despite the fact I haven't added any libraries.

As mentioned above, more than 50% of reviewers would appreciate it if there were more convenient input methods.

It seemed to me that the application was a bit slower on iPhone 5s than on Samsung S4 device. However, I haven't made any optimization in my application in order to increase its speed or decrease CPU usage. Nobody of reviewers haven't noticed a slower reaction on iPhone 5s. As phones get better and better hardware and Unity keeps getting more and more efficient, slower reaction of an application shouldn't be a problem.

Overall, I was satisfied with the interview results as well as with UI tests. Unfortunately, I didn't have enough time to fix the issue in Android application, but I'm convinced I will solve the problem with keyboard, input fields and application size in the near future.

3.3 Evaluation

This section contains two important parts. In the first one, development in Unity will be compared to native development from both software vendor's and customer's perspective. In the second one, restaurant chain's investment in mobile application developed in Unity will be assessed.

3.3.1 Development time

Before developing the application that was described in the previous chapter, I didn't have any experience with development in Unity or MS technologies. Thus, I had to spend some time on learning these tools. Taking it into account, it took me to implement:

- Database part of the application - 28 hours,
- Backend part - 42 hours,
- Frontend part - 40 hours, which makes a total of 110 hours of development.

3.3.2 Development in Unity vs native development

Software vendor's perspective

Unity has the biggest developer community in the world that counts 5 million people and keeps growing. [43]

The time it takes programmer to find an answer for his question is very important. Thanks to vibrant Unity community, special resource for questions exists - Unity Answers. It seems to me that questions there are getting answered much faster compared to resources for questions regarding development in iOS and Android SDK's. [44], [45] [46], [47]

Most of common features have been already developed by someone, thus, it's unnecessary to spend time on creating them again. Third-party solutions are being stored in libraries. For Android and iOS SDK's, there are lot of different websites that offer them. However, due to the fact that most of them are free and there isn't any official place for this purpose maintained by Google for Android or Apple for iOS, programmer could spend a lot of time on finding the right solution. Also, in most cases, he/she couldn't count on any support from developers of the solution, which may be a serious problem calling into question profitability of using third-party solutions.

Despite native ways of development, Unity has its own solution store - Asset store. There could be sold everything that may be helpful for others - from small scripts to complete applications. Usually, developers of the solution are very helpful. Reviews and ratings of the product, in most cases, are very reliable and may only be written by users that purchased the particular asset. Primary price range is 250-750 CZK. Assuming average time it takes to develop an asset is 30-40 hours and that the experienced programmer's hour rate is 250 CZK/hour, one asset could cost in average 15 times less than own implementation in Unity or more than 30 times less in case of development for two platforms. [40]

Moreover, Unity offers wide possibilities of code reusing, providing powerful instruments, such as:

- Component [48]
  - it is a script, built-in or custom one, that tends to be reusable,
- Prefab [49]
  - it is a component container template. Any change of it will reflect all its instances, except those which have their linkage manually broken.

Following paragraph is based on my own experience with Unity as well as on opinion of experienced Unity3D mobile game UI developer.

Unity platform allows to make applications more interactive. It is much easier to develop any kind of animation or special effect in Unity than in native SDKs. Thanks to application's intuitive graphical representation in Unity editor, as well as due to reusing instruments described above, it is possible to create UI parts of application by non-programmers. Prefabs allow to separate development process in order for graphical part to be prepared by graphic designers. Moreover, Unity offers wide range of UI layout designing thanks to new Unity UI system. Elements like tables and animations could be implemented without writing a code, considering some preparation by programmer. Assuming the fact that, in average, graphic designer has lower salary compared to mobile application developer and that graphic designer is more familiar with creating visual representation of an application, Unity could be extremely useful in this way. [50],[51]

However, there are some drawbacks of using Unity platform for business applications:

- larger application size - always will be more than 15 MB,
  - common problem of cross-platform development tools
- increased battery usage,

  - personally, I haven't noticed any changes in battery consuming on my Android phone during using the application, nor battery saver application did

- slightly higher requirements on mobile devices
- lack of built-in gestures and elements,
  - could be implemented manually or purchased as a third-party solution in Unity Asset Store
- custom UI application will not necessarily obtain Apple Store application approval,
  - common custom UI problem,
  - issue could be solved by gaining experience and analyzing Apple Store approval feedback.

In following three paragraphs I will try to evaluate development in Unity compared to native way of development in case of development by non-experienced programmers, experienced programmers and combined team of experienced and non-experienced ones.

I have some experience with development in iOS SDK, but almost no experience with development in Android SDK. My opinion is based on experience in programming, opinions of both Android and iOS programmers, as well as on mobile application tester's experience. Comparison presented below is subjective.

–Non-experienced developers

I consider implementation of mobile application similar to one that I have developed will take non-experienced programmer approximately 20% less time in Unity compared to iOS SDK:

$$\tau_u = 0.8 \times \tau_i \Longrightarrow \tau_i = 1.25 \times \tau_u \tag{3.1}$$

where τ_u is time it takes to develop application for iOS platform in Unity, τ_i is time it takes to develop application for iOS in iOS SDK.

For Android, I consider the time it will take to develop similar application in Unity will be 40% less compared to Android SDK:

$$\tau_u = 0.6 \times \tau_a \Longrightarrow \tau_a = 1.67 \times \tau_u \tag{3.2}$$

where τ_u is time it takes to develop application for Android platform in Unity, τ_a is time it takes to develop application for Android in Android SDK.

That is, assuming custom UI in Unity, development of mobile application for both Android and iOS platforms in Android and iOS SDK, compared to Unity, will take:

$$\tau_{ia} = 1.25 \times \tau_u + 1.67 \times \tau_u = 2.92 \times \tau_{u_0}, \tag{3.3}$$

where τ_{ia} - time it will take to develop mobile application for both Android and iOS using Android and iOS SDK, τ_u - time it will take to develop application for one platform in Unity, τ_{u_0} - time it will take to develop mobile application in Unity for both iOS and Android platforms, changes that are needed for editing application for other platform are not taken into consideration.

Considering the application developed in Unity will need some changes to function on the other platform, it will take 10% more time than calculated above:

$$1.1 \times \tau_u = \tau_{u_0} \Longrightarrow \tau_{ia} = 2.66 \times \tau_u, \tag{3.4}$$

where τ_u - real time it will take to develop application for both iOS and Android platforms using Unity, τ_{u_0} - time it will take to develop mobile application using Unity for both iOS and Android platforms, changes that are needed for editing application for other platform are not taken into consideration, τ_{ia} - time it will take to develop mobile application for both Android and iOS using Android and iOS SDK.

That is, it will take non-experienced programmers in average 2.66 less time to develop the pilot version of application with custom UI for both platforms in Unity compared to native SDK's. In case of using native SDKs for development, usually at least three programmers are needed - one for iOS platform, one for Android and one for development of backend/database. Development in Unity requires at least one programmer with basic knowledge of C# and SQL, because frontend and backend are both implemented in C# language.

I consider development of a real application in Unity will not be as effective as development of pilot version and that it could take 1.5 less time in Unity compared to native way of development.

–Experienced developers

Higher effectiveness of development by experienced programmers in Unity compared to native way of development may be caused by highly reusable code, Unity Answers website and the Unity Asset Store.

However, the question is too complex and requires deeper study as well as detailed experienced developers' survey. Thus, it would be improper to do any calculations or make any conclusions.

–Non-experienced and experienced developers

In case of development of an application by non-experienced developers with assistance of experienced ones, I suppose development in Unity will be slightly

more effective than in case of non-experienced programmers only because of well thought-out graphical representation and better code reusing.

Client's perspective

From customer's perspective, Unity is a flexible development platform that allows software vendors to reduce cost of an application. In addition, changes in application after its release, which are very important for business, should take less time and cost less compared to native way of development.

–Alternative method of use

Based on my own experience with Unity, as well as on opinions of two experienced Unity UI game developers, Unity platform is good at prototyping. In my practice as Mobile application tester, our company encountered not a few situations when customer found out what he needs only after whole application is created. Not infrequently, those changes would have meant redesign of application's UI, redesign of logic on both Android and iOS platforms, as well as on server side. Some of those requirements are later done and payed by customer, some of them are left, but this problem could be resolved if there will be a prototype of an application that customer could try and think about it for some time.

In the case of premium applications, additional usability tests should be considered. Potential users that are involved in it will naturally use gestures and areas of the screen in order to perform particular actions. Every gesture will be tracked. In conditions of usability laboratory, with user's feedback gained on each particular action, outputs could be significant.

Conclusion

A good software assumes changes. The bigger the change is, the more programmer's time is needed. In case of native development, the implementation labour cost is multiplied by count of platforms that application runs on, with additional expenses on coordinating and synchronizing the work on application for each platform. The issues found in application created using native way of development are mostly different for each platform, so due to the inconsistency it could additional time to fix them. In case of cross-platform development, especially one with custom UI, changes will be implemented once and after some additional work for adapting for each platform will work on each one the same way.

In addition, Unity, thanks to the fact it is cross-platform tool as well as to its good visualization, provides wide possibilities of using it in iterative method of development.

This, together with Unity's benefits over native way of development described above, makes Unity interesting platform for creating business applic-

ations to take a deeper look at. The most of drawbacks could be solved and it seems to me that in perspective most of them will be fixed.

3.3.3 Economic assessment

I will evaluate return on investment in mobile application by restaurant chain. Possible further expenses caused by application are not taken into account. Because I don't have access to any data about mobile application development costs except average programmer's salary, I will assume whole application will be created by one developer. Development by company could cost at minimum three times more. License costs are not taken into account in this evaluation.

The calculations below are made based on my own experience as well as on three returning customers' reviews. Possible further sources will be mentioned.

As I mentioned above, it took me about 100 hours to implement the whole application. Time for studying general aspects of development of the backend in .NET, database in MS SQL Server and frontend in Unity3D are not taken into consideration.

- With additional features like pop-up windows, time pickers and loading indicators added, it could have taken 160 hours.
- Taking into account that this was my first experience, it could have taken more experienced junior developer 120 hours.
- In order for application to be fully functional, stable and ready to be used by more than 1'000 users, it could have taken 220 hours of junior developer's time.

Assuming average hour rate of junior .NET developer is 180 CZK/hour, development cost of an application is 39'600 CZK. In regards to fact that product purchase is not the only phase in the software project, it is necessary to include software maintenance costs as well as upgrade costs. Mobile application life expectancy is set to 3 years, because mobile sphere is more dynamic than, for example, desktop application sphere. New UI design patterns are introduced every 1.5 years as well as average phone screen size gets bigger every year. Estimate maintenance cost is 1'500 CZK/month which will include major problem fixes as well as hosting fee. Upgrade cost is paid once and is set to 12'000 CZK and will include upgrade to new OS versions as well as some changes from the client after acceptance. Total application cost including maintenance for 3 years is estimated at 105'600 CZK. The following statistics were obtained during the bachelor's thesis work and some of them were already described in several sections above:

- main user group for mobile application - returning customers - generate in average 51% of fine dining restaurants revenue, [13]

- main target social classes of the restaurant are middle and upper middle, [52],[53]
- average amount spent on the dinner for two people is 900 CZK, [52],[53]
- the existing application was installed, in average, by 1'500 people - despite poor marketing campaign, [21]
- average net profit margin of fine dining restaurant is 17%, [54]
- customers are mainly in age of 25-32. [27]

Branch name	Year turnover, mln CZK
Grosseto Vinohrady s.r.o.	10-30
Grosseto Marina s.r.o.	60-100
Grosseto Průhonice s.r.o.	30-60
Grosseto Brumlovka s.r.o.	10-30
Grosseto Dejvice s.r.o.	10-30

Table 3.1: Grosseto restaurant chain branches' average year turnover. Source: [55],[56],[57],[58],[59],

registration as legal person is required. The information is also presented in chapter: Miscellaneous.

The following equations will help to calculate ROI in mobile application for restaurant chain.

The results are approximate and may not correspond to the real situation. Average year turnover of all Grosseto restaurant branches is:

$$T = T_V + T_M + T_P + T_B + T_D = 15 + 80 + 45 + 15 + 15 = 170, \tag{3.5}$$

where T - average year turnover of all Grosseto restaurant branches, T_V - average year turnover of Grosseto Vinohrady s.r.o., T_M - average year turnover of Grosseto Marina s.r.o., T_P - average year turnover of Grosseto Průhonice s.r.o., T_B - average year turnover of Grosseto Brumlovka s.r.o., T_D - average year turnover of Grosseto Dejvice s.r.o. All numbers above are measured in mln CZK.

That means that, taking into account the average amount spent in restaurant for one person is 450 CZK, total count of customers' visits per year is:

$$P = T \div A = 170000000 \div 450 = 377777, \tag{3.6}$$

where P is approximate yearly count of visits of Grosseto restaurant chain, T is average year turnover of all Grosseto restaurant branches in CZK, A is average amount spent in Grosseto restaurant by one person in CZK.

As I don't dispose any accurate data regarding count of active users of existing Grosseto application, I'll be basing on count of installations as well as on the users' feedback on both existing and new application. Considering better marketing campaign of new mobile application, I expect it will be installed by more than 2'500 returning customers, presuming 1'500 installations of existing application as well as the fact that it is more likely for customer to own iPhone rather than Android device due to dominating middle and upper middle social class among clients. [21]

Basing on my own experience as well as on three returning customers' reviews, Grosseto restaurant chain is visited in average 3 times a month by returning customers - keeping in mind that existing mobile application isn't very successful from UI design perspective. Estimated count of returning customers is calculated below. The fact that mobile application's target audience is mainly returning customers is taken into account.

$$R = \frac{P \times X}{V \times Y} = \frac{377777 \times 0.51}{3 \times 12} = \frac{377777 \times 0.51}{36} = 5352, \tag{3.7}$$

where R - approximate count of returning customers of Grosseto restaurant chain, P - approximate yearly count of visits of Grosseto restaurant chain, X - percentage of revenue generated by returning customers, V - average count of visits of returning customer per month, Y - count of months in a year.

Due to lack of objective information, the following conclusions are based only on my own experience as well as on three returning customers'.
If there was a simple and clear mobile application, I expect I'd visit Grosseto restaurant at least 1 more time every two months, that means I'd visit Grosseto restaurant chain 6 more times a year. That is, assuming only 1'000 users of the new application, the turnover of the restaurant chain gained from increased visits of this customer subgroup will increase by T_{1000}:

$$T_{1000} = U \times F \times A = 1000 \times 6 \times 450 = 2700000, \tag{3.8}$$

where T_{1000} - yearly revenue generated by 1'000 users of new application in CZK, U - expected minimal count of users of new application, F - increase in frequency of visiting Grosseto restaurant chain by new application users caused by new application measured in visits per year, A - average amount spent in Grosseto restaurant by one person in CZK.

Profit net income is counted below, taking into account average fine dining net income margin of 17%.

$$17\% = \frac{T_{1000} - C_{1000}}{C_{1000}} = \frac{2700000 - C_{1000}}{C_{1000}} \Longrightarrow C_{1000} = 2308000 \tag{3.9}$$

$$I_{1000} = T_{1000} - C_{1000} = 2700000 - 2308000 = 392000, \tag{3.10}$$

where T_{1000} - yearly revenue generated by 1'000 users of new application in CZK, C_{1000} - net cost of sold products in CZK, I_{1000} - net income gained from 1000 users thanks to increased number of their visits in CZK.

Taking into consideration the fact that new users will be installing application gradually, I've created a table that reflects net income that depends on increasing user count as well as on months from application release. Therefore, amount of year net income below is lower than one calculated above.

Months	1	2	3	4	5	6	7	8	9	10	11	12
Users	400	450	500	550	610	670	730	790	850	910	970	1030
Income	13	28	44	62	82	104	128	154	181	211	242	275

Table 3.2: Estimated net income gained from increased number of visits,

where "Months" is count of months after application release, "Users" is count of users of new application, "Income" is net income generated thanks to the new application measured in thousands of CZK.

Assuming the cost of a mobile application including support for one year is 69'600 CZK, the investment in it should return in less than a year.

$$Z_{1000} = \frac{I_{1000} - M_{1000}}{M_{1000}} = \frac{275000 - 69600}{69600} = 2.95, \tag{3.11}$$

where Z_{1000} is ROI in mobile application, I_{1000} is net income gained from 1000 users thanks to increased number of their visits in CZK, M_{1000} is cost of mobile application that includes support for one year in CZK.

It is worth reminding that cost of an application developed by software company could be up to 3 times more assuming usage of Unity as well as that expenses on marketing campaign are not included. Although, keeping in mind that it is a long-term investment, it will be still a good investment.

Later, CRM system and a mobile application for waiters should be considered in order to take advantage of all opportunities mobile application could provide. In case of application for personnel, Unity could be particularly useful thanks to wide possibilities of custom UI design.

Conclusion

In this work, I was exploring the possibilities of cross-platform development in Unity, namely, business applications for mobile devices. I have chosen to conduct the case study for Grosseto restaurant chain. Despite the fact I wasn't able to arrange on cooperation, I tried to use all available sources for specification of requirements and evaluation of the results.

After the overview of existing applications for restaurants, I attempted to develop the new one that wouldn't repeat mistakes found in existing applications, meeting both user and the restaurant management requirements.

Summarizing the results of using Unity as a platform for business applications development, I'd like to note that it has surpassed my expectations. Consistency and unification along the whole process of development in Unity create favorable conditions for creating mobile applications for business. There are several drawbacks in development in Unity, among which there are larger application size, increased battery usage and lack of native UI elements. However, taking into attention increasing processing power of mobile devices, optimization of resource consumption by Unity, more than 5 million Unity developers community with its own successful 3rd party solutions store and desire of businesses to stand out, I consider Unity has the potential to become a successful tool for cross-platform mobile business applications development.

While assessing restaurant chain's investment in mobile application, it turned out that in case of development by one programmer, amount spent on it will return in less than a year. Results regarding the cost of application were based on time it took me to implement the pilot version of application. Given that the cost of application including support for one year is 69'600 CZK, expected net income gained from usage of application by 1'000 users will be 275'000 CZK, which means a ROI of 2.95. Later, CRM system and mobile application for waiters should be considered in order to take advantage of opportunities mobile application could provide. Connected with POS, wisely used outputs from those systems and applications could fundamentally change customers' loyalty and bring outstanding results. Even considering cost of

application developed by company will be four times higher, it would still be a good long-term investment that could give Grosseto restaurant chain strong competitive advantage.

Work on this bachelor's thesis was very enriching experience for me. I have deepened my knowledge in marketing business process, understood how important analysis could be in order to create a good product and also dispelled misconceptions regarding mobile application development process. I have acquainted with various modern technologies like Unity platform and .NET framework, as well as with C# language. During my work, Unity 5 was released as well as Visual Studio 2015 did, where various steps were taken in order to improve compatibility with cross-platform mobile application development tools. The most valuable experience for me was that I have managed to switch the roles like programmer, project manager, UI designer, business analyst, business stakeholder and potential user. This experience helps me a lot in my mobile application tester's job.

All objectives that were set in the assignment have been met. In nearest future, I'm going to improve the application and explore the Unity Asset store. After a fully functional application will be developed, I consider offering mobile application development to restaurant chains. I will use this bachelor's thesis in order to help potential client learn about the opportunities mobile application could provide for his/her business.

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Appendix A

Tutorial - business applications in Unity

Figure below demonstrates Unity editor.

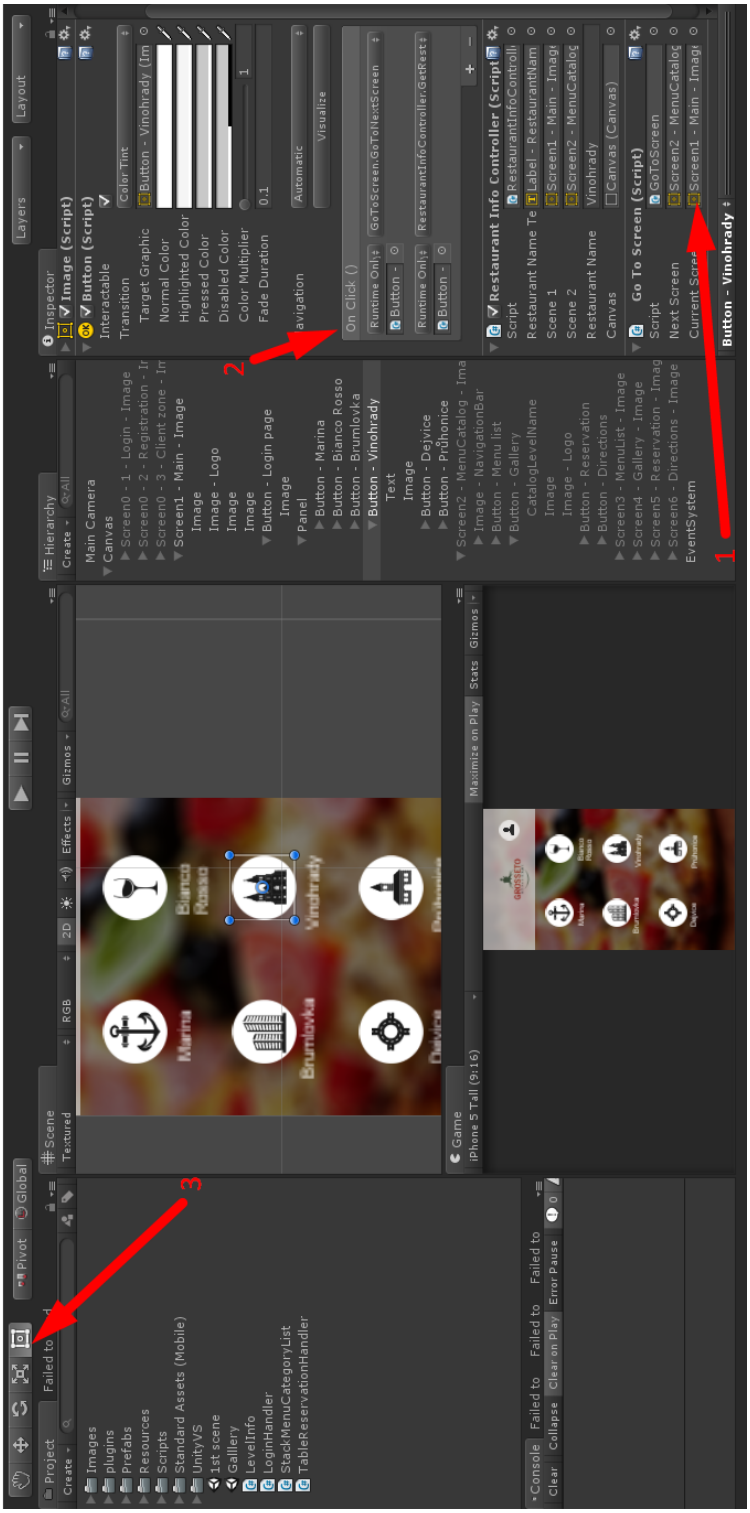

Figure A.1: Unity editor

On the figure above, label number 1 stands for the public property "Current Screen" of the script "Go To Screen". Simultaneously, the script "Go To Screen" is a class derived from the base class MonoBehaviour, as well as a Component of "Button - Vinohrady" GameObject.
Label number 2 stands for "On Click" method that is implemented by default in Button Component. Method that is called after clicking the Button could be selected through the Unity editor as well as from the Visual Studio.
Label number 3 at the top left corner stands for scene control tools. The color scheme of the editor is dark and not light because I was using 30-day trial version during last month of development. Free version has light color scheme. More about the Unity Editor could be found at the following tutorial.

Information that could be useful for beginning programmers of business applications in Unity is presented below.

1. The latest version of Unity3D could be downloaded from the following link.

2. The free version of Microsoft Visual Studio could be downloaded from the following URL.

3. In order to connect Unity with Visual Studio for debugging and developing logical parts of an application, Visual Studio Tools version that corresponds to the installed version of Visual Studio should be downloaded from the Visual Studio Gallery website.

4. For more convenient programming, ReSharper tool for Visual Studio should be downloaded from the following URL. Free 30-day trial is available.

5. In order to deploy an Android application from Unity, latest JDK should be downloaded from this URL

6. For deployment on iOS devices following conditions should be fulfilled:

    - Apple Developer Account license is needed. One could be purchased at this URL, item Mac OS availability,
    - Installed XCode IDE.

7. The guide on Unity UI system could be found at this URL.

Appendix B

Miscellaneous

Name	Address	ZIP	City	Turnover
Grosseto Marina s.r.o.	Petrská 1426/1	11000	Praha 1	60–100 mil. Kč
Grosseto Průhonice s.r.o.	Petrská 1426/1	11000	Praha 1	30–60 mil. Kč
Grosseto Brumlovka s.r.o.	Petrská 1426/1	11000	Praha 1	10–30 mil. Kč
Grosseto Dejvice s.r.o.	Petrská 1426/1	11000	Praha 1	10–30 mil. Kč
Grosseto Vinohrady s.r.o.	Petrská 1426/1	11000	Praha 1	10–30 mil. Kč

Figure B.1: Average year turnover of Grosseto restaurant branches. Source: [55],[56],[57],[58],[59]

Appendix C

Acronyms

PC Personal Computer

GUI Graphical User Interface

UI User Interface

UX User Experience

OS Operating System

CZK Czech Koruna

CRM Customer Relationship Management

MS Microsoft

SQL Structured Query Language

GUID Globally Unique Identifier

ASP Active Server Pages

ORM Object-Relational Mapping

LINQ Language-Integrated Query

IDE Integrated Development Environment

QR Quick Response

POS Point Of Sale

XML Extensible Markup Language

SDK Software Development Kit

FIT CTU Faculty of Information Technologies at Czech Technical University in Prague

MVC Model View Controller

URL Uniform Resource Locator

JSON JavaScript Object Notation

CPU Central Processing Unit

MB Megabytes

MLN Million

ROI Return On Investment

Appendix D

Contents of enclosed CD

- `readme.txt` ..... the file with CD contents description
- `exe` ..... the directory with executables
- `src` ..... the directory of source codes
  - `wbdcm` ..... implementation sources
  - `thesis` ..... the directory of LaTeX source codes of the thesis
- `text` ..... the thesis text directory
  - `thesis.pdf` ..... the thesis text in PDF format