Czech University of Life Sciences Prague

Faculty of Economics and Management

Department of Information Technologies

Diploma Thesis

Development of web application based on open data

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CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

Faculty of Economics and Management

DIPLOMA THESIS ASSIGNMENT

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Informatics

Thesis title

Development of web application based on open data

Objectives of thesis

The main goal of this diploma thesis is to design and develop a web application which will make use of open data in order to provide meaningful information about foreigners living in Czech Republic.

Partial goals of the thesis are such as:
- Making a literature review of the current state of Open Data analyzing the advantages and disadvantages.
- Making an analysis and design of a web application based on Open Data of the Czech Statistical Office.
- Evaluating the developed application and formulating conclusions.

Methodology

The theoretical part will be focused on the study and analysis of Open Data, accounting their advantages, disadvantages and its use. The practical part is based on using software engineering methods such as Use Case, UML class diagrams and prototyping. The proposal of working application prototype will be presented here. The application will be analyzed and evaluated regarding other existing solutions. Final conclusions will be constructed with a synthesis of theoretical knowledge and practical outcomes.

The proposed extent of the thesis

60 – 80 pages

Keywords

Open Data, Open Access, Data Set, Reuse and Redistribution Data, Web Application, Foreigners in Czech Republic, European Union Open Data, Sofware engineering, PHP 5, HTML5, CSS3, UML.

Recommended information sources

Al-Khouri, A. M. "Open data: A paradigm shift in the heart of government." Journal of Public Administration and Governance 4.3 (2014): 217-244.

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Nixon, R. Learning PHP, MySQL, JavaScript, CSS & HTML5: A Step-by-Step Guide to Creating Dynamic Websites. O'Reilly, 2014. ISBN: 9781491949450

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Declaration

I declare that I have worked on my diploma thesis titled "Development of web application based on open data" by myself and I have used only the sources mentioned at the end of the thesis. As the author of the diploma thesis, I declare that the thesis does not break copyrights of any their person.

In Prague on 22th March, 2017 _____

Bc. Mario Nivardo Villanueva Duran

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I would like to thank to my tutor Ing. Miloš Ulman, Ph.D., to my parents Raul German Villanueva Mequi and Aurora Duran Sacaca and all other persons, for their advice and support during my work on this Thesis.

Vývoj webová aplikace založená na Otevřený dat

Souhrn

Cílem této práce je prozkoumat a poskytnout přehled o otevřených datech v České Republice. Práce je zaměřena především na otevřená data o zaregistrovaných cizincích, které žijí v České republice poskytnutých ve formě otevřených datových sad Českým statistickým úřadem (ČSÚ).

Webová aplikace bude vyvinuta na základě responzivního webového návrhu založeného na procesu vývoje softwaru s využitím technologií HTML5, CSS3 a JavaScript. Za účelem dosažení interaktivity aplikace budou použit modul CEZET Map, které umožňuje tvorbu interaktivní mapy České republiky a modul Highcharts JS, který slouží ke tvorbě interaktivních grafů. Tyto nástroje napomáhají srozumitelnosti výsledných statistik pro koncového uživatele, aniž by byl v dané oblasti znalý. Uživatelé mají možnost interakce s grafy a zároveň se mohou zaměřit na statistiky, které je zajímají.

Kromě definice otevřených dat, a jak mohou být otevřená data užitečná v různých oblastech, bude jejich princip vysvětlen i na příkladech aplikací, která otevřená data využívají. V současném digitálním věku je velmi pravděpodobné, že se otevřená data a jejich použití rozšíří s expanzí internetu, protože zastávají úlohu, která mění vztah mezi občany a vládou. V těchto dnech mnozí občané již nepřijímají pasivní přístup zastupitelské demokracie. Otevřenou vládu je třeba vidět v kontextu práv občanů: právo, aby se aktivně podíleli na procesu stanovování agendy a rozhodování.

Klíčová slova: Otevřená data, datové sady, opětovné využití, redistribuce dat, webové aplikace, cizinci v České republice, proces vývoje softwaru, HTML5, CSS3, JavaScript, Highcharts JS, CEZET Map.

Development of web application based on open data

Summary

This thesis attempts to explore and provide an overview of Open Data in the Czech Republic. Mainly focused on data set of registered foreigners living in the Czech Republic based on open data set of Czech Statistical Office CZSO.

A web application will be developed using a responsive design based on the software development process (SDLC) using HTML5, CSS3 and JavaScript. In order to make an interactive application will be used CEZET Map to create an interactive map of the Czech Republic and Highcharts JS to create an interactive charts which makes the statistics more understandable. in the eyes of any user without the need to have knowledge in statistics because users has the options to interact with the Charts to focus on the statistic they are interested in.

Furthermore concepts about open data and how it can be useful in different areas will be explained with examples of applications using open data. In this digital age open data is very likely to increase with the rise of the Internet, because it stands for the changing relation between citizens and government. In these days many citizens no longer accept the passive stance representative democracy held for them. Open Government is to be seen in the context of citizens' rights: the right to actively participate in the process of agenda-setting and decision-making.

Keywords: Open Data, Data set, Reuse, Redistribution Data, Web Application, Foreigners in the Czech Republic, Software development process, HTML5, CSS3, JavaScript, Highcharts JS, CEZET Map.

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1 Introduction

In Europe, open data has been on the agenda for some years and is continuing to gain ground. Starting with the EU Directive 2003/98/ EC the efforts to create common framework for the re-use of public data by governments, private companies and others has involved into a strong movement by the European Commission, But open data was not just gaining ground in the EU countries also there are numerous initiatives in developing countries around the world.

Open data is very likely to increase in this new century with the rise of the Internet, because it stands for the changing relation between citizens and government. In these days many citizens no longer accept the passive stance representative democracy held for them. Open Government is to be seen in the context of citizens' rights: the right to actively participate in the process of agenda-setting and decision-making.

This thesis attempts to explore and provide an overview of Open Data in the Czech Republic. Mainly focused on data set of registered foreigners living in the Czech Republic based on open data set of Czech Statistical Office CZSO. The fields to be analyzed are such as Total number of foreigners, Demographic events of foreigners, Acquisition of Czech citizenship, Education, Employment, Criminality and Illegal migration in order to generate meaningful statistics which can benefit the municipality, community, companies, tourists or anyone who can find it useful. A web application will be developed using HTML5, CSS3, JavaScript and in order to create an interactive map of the Czech Republic will be used CEZET Map and finally to create an interactive charts which makes the statistics more understandable will be used Highcharts JS. Furthermore, a web application will be developed using a responsive design based on the software development process, also known as a software development life cycle (SDLC) which takes a project through several phases such as: requirements, design, implementation, testing, deployment and maintenance.

Furthermore concepts about open data and how it can be useful in different areas will be explained with an examples of applications using open data.

2 Objectives and Methodology

2.1 Objectives

The main goal of this diploma thesis is to design and develop a web application which will make use of open data in order to provide meaningful information by using interactive statistics about foreigners living in the Czech Republic.

Partial goals of the thesis are such as:

- Making a literature review of the current state of Open Data analyzing the advantages and disadvantages.
- Making an analysis and design of a web application based on Open Data of the Czech Statistical Office CZSO.
- Evaluating the developed application and formulating conclusions.

2.2 Methodology

The theoretical part will be focused on the study and analysis of Open Data, accounting their advantages, disadvantages and its use. The practical part is based on using software engineering methods such as UML Usecase diagram and prototyping. The proposal of working application prototype will be presented here. The application will be analyzed and evaluated regarding other existing solutions. Final conclusions will be constructed with a synthesis of theoretical knowledge and practical outcomes.

3 Literature Review

3.1 Open data definition

The principle of Open Data means that certain information must be available and easily accessible to everyone to use, modify and share as they wish, without restrictions from copyrights, patents or other mechanisms of control.

It makes precise the meaning of "open" in the terms "open data" and "open content" and thereby ensures quality and encourages compatibility between different pools of open material. Open data and content can be freely used, modified, and shared by anyone for any purpose. (Opendata.org) [1]

Open Data is "going to help launch more startups. It's going to help launch more businesses, etc. It's going to help more entrepreneurs come up with products and services that we haven't even imagined yet" (President Barack Obama, May 9, 2013).

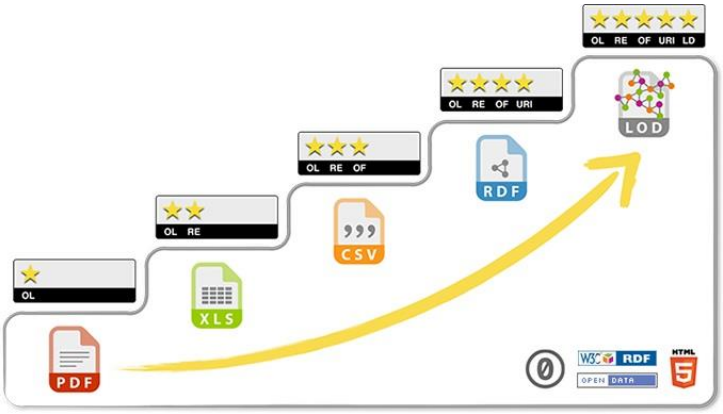
Open Data does not mean that government or public entities must open all their data to the public. There are concerns preventing this, for instance: copyrights, fear of loss of control, and lack of resources needed to Open Data. If the government made all personal information accessible, the privacy of everyone would be compromised. In other words, *Open Data* means that whatever data is released should be released in a specific way to allow the public to access it without having to pay fees or be unfairly restricted in its use.

Open Data is becoming a secret to success for smart business leaders around the world, taking us into a new territory, with more powerful computers, cheaper memory storage, and the exponential growth of digital information, which is taking Open Data to an entirely new level and changing our world in the process.

3.2 Five star open data

Five star open data has been suggested by Tim Berners - Lee, who has invented the World Wide Web (WWW). In the following pages will be explained in detail each of these levels. [2]

Figure 1 5 Stars open data



Source: Tim Berners-Lee, 2014

3.2.1 One star

This represents the lowest level of the data which is made available on the Web under open license in whatever format of choice such as Imgens, Word-processing documents or **PDF** documents which reflect the positioning of entities on the page, not their logical structure, which is correspondingly difficult or impossible to extract automatically. Figure 2 PDF format.

Figure 2 Format of one star open data

Total Foreigners in CZ in years 2010 – 2015

Year	Total
2010	1,495
2011	1,936
2012	2,036
2013	2,514
2014	5,114

Source: Czech Statistical Office

However, this level provides some costs and benefits for consumers and publishers.

As a consumer:

- Analyze the data
- Print the data
- Download and store it locally on a hard drive or on an USB
- Enter the data in to any other system.

- Modify and share it.

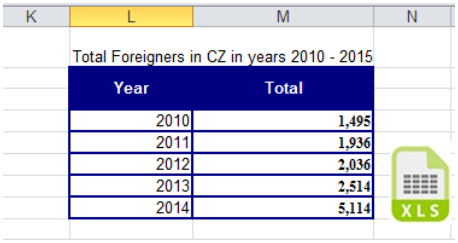
As a publisher:

- Publish the data without any restrictions from copyrights, patents or other mechanisms of control, allowing the consumer to freely use it and distribute as they wish.

3.2.2 Two stars

The second level involves publishing data as machine-readable structured data. It means data must be extracted easily and displayed nicely by computer programs, preferably by downloading freely over the internet such as an Excel spreadsheet.

Figure 3 Format of two start



K	L	M	N

Total Foreigners in CZ in years 2010 - 2015

Year	Total
2010	1,495
2011	1,936
2012	2,036
2013	2,514
2014	5,114

Source: Czech Statistical Office

However, the data is still locked-up in a document; it means that in order to get the data out of the document must be used proprietary software.

As a consumer:

- Directly process the data using proprietary software to manipulate it, aggregate it, perform calculations, visualize it, etc.
- Export it into another format
- Publisher still has the benefits of the first level.

3.2.3 Three stars

In this third level the published data are using non-proprietary format such as CSV - Comma Separated Value instead of Excel, allowing everyone to manipulate this data easily.

Figure 4 Format of three star open data

```
Total Foreigners in CZ in years 2010 - 2015,
Year,Total
2010,"1,495"
2011,"1,936"
2012,"2,036"
2013,"2,514"
2014,"5,114"
```

Source: Czech Statistical Office

As a consumer will benefit from the first two levels and additionally:

- Manipulate the data in any way that seems appropriate to the consumers, without the need to own any proprietary software package.

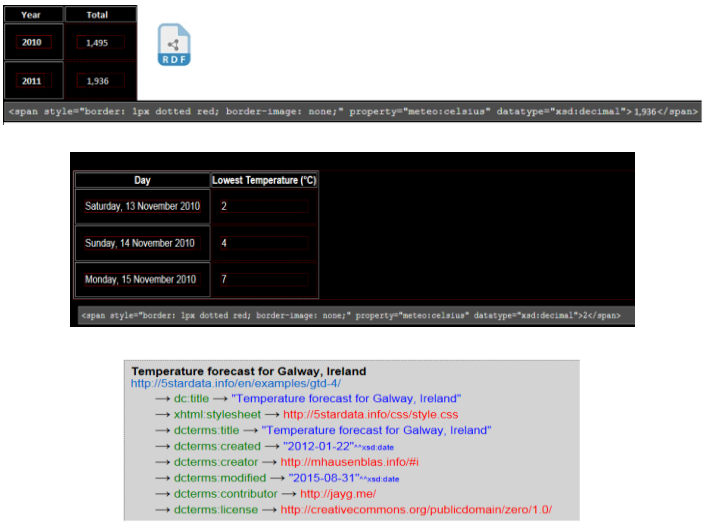
As a publisher:

- In order to export the data from the proprietary format they might need a correct converters or plug-ins.
- The data is still rather simple to publish.

3.2.4 Four stars:

In this fourth level the published data use URI's to denote elements in the dataset, so everyone can point to those elements. Instead of having data on the Web, the data is now in the Web. RDF represents data in a native format, but there are other formats such as Atom which can be converted and mapped if required.

Figure 5 Format of four star open data



Source: Lee, n.d.

As a consumer has all the benefits of the previous levels and additionally:

- Link the data from any other place; it could be locally or on the web.
- Save data as a bookmark.
- Reused parts of the data.
- Existing tools and libraries are reuseable, even if the consumers only understand partial parts of the pattern of which the publisher used.
- For them to understand the RDF data structure it can be more complexed than tabular format such as Excel and CSV or tree format such as XML and JSON data.
- Combine the data safely with other data. URI is well on the way to be a 5 star level when URI which are global scheme are given two of the same URI's intentionally.

As a publisher:

- In order to optimize their access such as load balancing, caching, etc, they have a fine granular control over the data items.
- Can achieve the 5 star level by linking their data to another publishers data.
- Formatting and modifying data can be very time consuming
- Assign URIs to data items, considering how to represent the data.
- Creating their own or reusing an existing pattern.

3.2.5 Five stars

In this level it's not all about putting data on the web, it's about making links, which benefits both the consumer and publisher from the network effect.

As a consumer has all the benefits of the previous levels and additionally:

- While consuming data they can at the same time discover more related data.
- Data scheme can help them learn directly.

- Consumer will have to deal with common broken data links, just like 404 error.
- Trust and common sense are all still necessary when presenting data from an arbitrary link as it is extremely risky letting people include content from any website to your pages.

As a publisher:

- Make their data discoverable.
- Increase the value of their data.
- Own organization will gain the same benefits from the links as the consumers.
- Publisher will need to invest resources to link their data to other data on the Web.
- Broken or incorrect links may need to be repaired.

3.3 File format of Open Data

The most used data formats are:

JSON (**J**ava**S**cript **O**bject **N**otation) is a simple file format that is very easy for any programming language to read. It is mainly used for storing and exchanging data between a browser and a server.

JSON Syntax Rules:

- Data is in name/value pairs
- Data is separated by commas
- Curly braces hold objects
- Square brackets hold arrays

XML (Extendible Markup Language) is a simple, very flexible text format derived from SGML. It allows the data interpretation for different language and it is the most used format of its kind over the world for sharing structured information and data exchange because it gives good opportunities to keep the structure in the data.

XML has a number of advantages over many other formats that gives advantages such as:

- **Redundancy** XML markup is very verbose, every end *tag* must be supplied; example: <*family*> ... </*family*>, this lets the computer catch common errors such as incorrect nesting.
- **Network effect** Any XML document can be read and processed by any XML tool and of course XML format itself can be read by any XML parser.
- **Self-describing** XML document format can be easily understood.

RDF (Resource Description Framework) is an application of XML that imposes structural constraints to provide unambiguous methods of expressing semantics and additionally provides a means for publishing both human-readable and machine-processable vocabularies designed to encourage the reuse and extension of metadata semantics among disparate information communities. Additionally, this permits the exchange and connection of data and resources through different applications, without losing their meaning, which simplifies the reuse and the enrichment of web resources.

RSS (Really Simple Syndication) It is a commonly used format method by which web content can be easily and quickly distributed when something is changed or newly entered into a website content such as news, blogs or podcasts etc.

CSV (Comma Separated Values) is a common data exchange format that is widely supported by consumer, business, and scientific applications. Among its most common uses is moving tabular data between programs that natively operate on incompatible formats. This format is commonly used to transfer large sets of data with the same structure.

This format may be a better choice especially in requirements that utilize high-cost bandwidth and where large amounts of data must be moved often. Hybrid implementations that convert to and from CSV where bandwidth is critical could also be a workable solution in some designs.

ODATA (Open Data Protocol) is an open protocol that grants queries and selections to be made directly in the provided datasets, and later downloads the resulting sets.

Spreadsheets are a table of values arranged in rows and columns. Each value can have a predefined relationship to the other values. Commonly used software is Microsoft Excel.

Text Document Classic documents formats such as: Word, ODF, OOXML, or PDF may be sufficient to show certain kinds of data, but PDF files are not structured.

3.4 The key features of opennes

Availability and accessibility it means data must be available easy, accessible, modifiable and convenient form. If there is some cost to be paid it should be just the production cost and been downloaded over the internet.

Reuse and redistribution must be guaranteed under the terms that permit reuse and redistribute it, also should allow to mix with other datasets. Data must be machine-readable.

Universal participation everyone must be able to use, reuse and redistribute as they wish without any discrimination against persons or groups.

3.5 The key reasons of openness

The reason to be open depends on the type of data. However, there are common reasons such as: [3]

Transparency citizens in a well-functioning, democratic society needs to know what the government are planning and expecting to do. For that reason, it requires the material to be open so they can be freely used, reuse and share those data with other citizens.

Releasing social and commercial value data is a key resource for social and commercial activities in this digital age that is currently building. To help the creation of innovative business and services that produce useful social and commercial value, the government should open there data because of the vast majority of useful data they have.

Participation and engagement Most citizens are only able to engage with their own governance infrequently at an election period that occurs within an interval of 4 or 5 years. Citizens would be able to have much more knowledge of what is happening and

the process of governance and being able to contribute in decision making if they decide to open the data.

3.6 Legal openness

In most jurisdictions, there are intellectual property rights that prevent third-parties from using, reusing and redistributing data without explicit permission. In order to make data available it has to be licensed. Open Data is recommended to be used as one of the licenses conformant with Open Definition and marked as suitable for data. [4]

Table 1 Recommended conformant licenses

License	Domain	By	SA	Comments
Creative Commons CCZero (CC0)	Content, Data	N	N	Dedicate to the Public Domain (all rights waived)
Open Data Commons Public Domain Dedication and License (PDDL)	Data	N	N	Dedicate to the Public Domain (all rights waived)
Creative Commons Attribution 4.0 (CC-BY-4.0)	Content, Data	Y	N	
Open Data Commons Attribution License (ODC-BY)	Data	Y	N	Attribution for data (bases)
Creative Commons Attribution Share-Alike 4.0 (CC-BY-SA-4.0)	Content, Data	Y	Y	
Open Data Commons Open Database License (ODbL)	Content, Data	Y	Y	Attribution-ShareAlike for data(bases)

Source: Conformant Licenses – Open definition

Open standards generally understood as technical standards which are free from licensing restrictions, and legal or technical clauses that limits its utilization which allows people to share it freely with perfect fidelity, and are developed in a vendor neutral manner.

3.7 Principles of Open Government Data

"Open data is about taking government records, public records, and putting them in the public domain where they are made freely available on a regular/timely basis to private citizens, civil society, and institutions, so that they can be reused to provide better services and to create jobs." (Rohlin, 2014).[31]

OGD is a worldwide movement to open up government/public administration data, information and content to both human and machine-readable non-proprietary formats for re-use by civil society, economy, media and academia as well as by politicians and public administrators. This applies only to data and information produced or commissioned by government or government-controlled entities and is not related to data on individuals.

The basic idea of Open Government is to establish a modern cooperation among politicians, public administration, industry and private citizens by enabling more transparency, democracy, participation and collaboration. In European countries, Open Government is often viewed as a natural companion to e-government[2]

In 2007, 30 Open Government advocates gathered in Sebastopol, California and wrote a set of eight principles of open government data. [5]

Complete All public data is made available it means it's not subjected to valid privacy, security or privilege limitations.

Primary Data is as collected from the main source, with the highest possible level of granularity, not in aggregate or modified forms.

Accessible Data is available to a large range of users for the widest range of purposes.

Timely Data is made available as quickly as possible to preserve the value of the data.

Machine processable Data is reasonably structured to allow automated processing.

Non-discriminatory Data is available to anyone, with no requirement of registration.

Non-proprietary Data is available in a format over which no entity has exclusive control.

License-free Data is not subject to any copyright, patent or trademark regulation. Reasonable privacy, security and privilege restrictions may be allowed.

The two principles added by the Sunlight Foundation are as follows: [6]

Permanent Data should be made available at a stable Internet location indefinitely and in a stable data format for as long as possible.

Usage costs The cost imposed on the public for access even when the minimum is one of the greatest barriers to access to information.

3.8 Open Data in the Czech Republic

As it was mentioned on the above this thesis is mainly focused on open data set of foreigners living in the Czech Republic provided by CZSO. [7]

3.8.1 Czech Statistical Office (CZSO)

CZSO is a central body of the state administration of the Czech Republic. It was established on 8 January 1969 by the Act No 2/1969 Sb., passed by the Czech National Council, on establishment of ministries and other institutions of central government of the Czech Republic. They have divided statistical data for citizens into clearly arranged topics. Table 2.

CZSO's Website has each topic/area which provides the following structure of information:

- **Statistical data** are provided in tables and graphs. About used data set will be explained in detail in the practical part.
- **Methodology** provided information/data collection is based under certain Czech laws. In this section the Czech laws are define.
- **Analyses and commentaries** abut of the given statistical area.
- **Related information** more useful information which are linked to the same topic.

Table 2 Statistics of the Czech Statistical Office

CZSO Statistics	
Agriculture	Living conditions, Household Income and Expenditure
Business Cycle Surveys	Population
Census	Prices, Inflation
Construction, Dwellings	Retail Trade, Hotels and Restaurants
Crime, Accidents	Science, Technology and Innovation
Culture	Services
Education	Social Security
Elections	Tourism
Employment, Unemployment	Transportation, Inf. and Communication
Environment	Cross-sectional statistics
External Trade	**Foreigners**
Financial Data	Gender Statistics
Forestry	Senior citizens
GDP, National Accounts	Summary data on the CZ
Health Care, Incapacity for Work	Regional statistics
Industry, Energy	Macroeconomic Indicators
Information Technologies	European data - ESDS
Labour and Earnings	International data

Source: Czech Statistical Office (CZSO)

3.8.2 Total number of foreigners

For many foreigners, the Czech Republic is the country they chose to begin a fresh start, one of the main reasons is the economy and life style. The latest numbers indicate more and more foreigners are hoping to gain long term residency. According to the latest data provided in **2015** it was the highest recorded statistics in the country's history, exactly **464,670** people were foreigners which is almost double from what it was in 2004 when the country joined the European Union.

Many of the migrants are living in the country for more than five years, which means that they could be granted a permanent residence.

The Ministry of the Interior of the Czech Republic are providing a pre-departure information package which is called **"Next Stop The Czech Republic"** which consists

of a brochure and a film. This information pack is intended for citizens of non-EU countries who are considering residing in the Czech Republic for longer than 90 days and will therefore need to apply for either a long-term visa or a long-term residence permit this information is available in Czech, Russian, Ukrainian and Vietnamese languages.

Statistics on foreigners are processed within the framework of policy for Integration of immigrants, which is updated every year on a Decision of the Government of the Czech Republic.

The foreigner statistics are published in complicated and user-unfriendly PDF and Excel formats. This data set will be used in the practical part in order to produce a meaningful calculations and predictions.

All the data sets are provided in Excel and PFD format by the Czech Statistical Office, which belongs to the lowest level of open data according to the five star system.[8]

3.8.3 Foreigners by type of residence

CZSO reveals exactly how many registered foreigners are living in the Czech Republic, from which countries they are from, to which districts they live in. These data sets contain information of foreigners with a Permanent residence and Long-term residence over 90 days in years 1985 – 2015. But until 1992 it was still Czechoslovakia a sovereign state that existed from October 1918, when it declared its independence from the Austro-Hungarian Empire till its peaceful dissolution into the **Czech Republic** and Slovakia on 1 January 1993. Table 3.

Table 3 Foreigners by type of residence in years 1985 - 2015

Year	Total	Permanent stay	Long term stay over 90 days
1985	37,177	27,892	8,891
1986	34,803	27,278	7,146
1987	34,933	27,310	7,263
1988	35,298	27,320	7,615
1989	35,561	27,325	7,899
1990	35,198	27,204	7,695
1991	38,002	28,457	9,204
1992	49,957	29,145	20,428
1993	77,668	31,072	46,070
1994	104,343	33,164	71,179
1995	159,207	39,242	119,965
1996	199,152	46,388	152,764
1997	210,311	56,797	153,514
1998	220,187	64,352	155,835
1999	228,862	66,754	162,108
2000	200,951	66,855	134,096
2001	210,794	69,816	140,978
2002	231,608	75,249	156,359
2003	240,421	80,844	159,577
2004	254,294	99,467	154,827
2005	278,312	110,598	167,714
2006	321,456	139,185	182,271
2007	392,315	157,512	234,803
2008	437,565	172,191	265,374
2009	432,503	180,359	252,144
2010	424,291	188,952	235,339
2011	434,153	196,408	237,745
2012	435,946	212,455	223,491
2013	439,189	236,557	202,632
2014	449,367	249,856	199,511
2015	464,670	260,040	204,630

Source: Czech Statistical Office, Directorate of Alien Police Service

There are two type of residence: [9] [15]

Permanent residence is for family members of citizens of the EU or Czech Republic. A foreign national (EU country or third-country citizen), who is in a family relationship with a citizen of the EU or Czech Republic within the framework stipulated in Article 15 of the Foreigners Act. Nevertheless, is not the only prerequisite of granting a permanent residence permit; other conditions stipulated in § 87h of the Foreigners Act must also be complied such as:

- 5 years of uninterrupted temporary stay in the territory Article 87h, paragraph 1, letter a/ of the Foreigners Act.
- 2 years of uninterrupted temporary stay in the territory provided that the applicant has been a family member of the EU or a Czech citizen with a registered permanent residence in the territory, (§ 87h, paragraph 1, letter b) of the Foreigners Act.
- Other preconditions issues of a permanent residence permit to a family member of an EU or a Czech citizen are specified in (§ 87h, paragraph 1, letter c) of the Foreigners Act.

Long-term residence it's a visa to stay exceeding 90 days which is issued by the Ministry of the Interior of the Czech Republic at the request of a foreigner national who plans to stay here for any purpose such as: employment, business, study or research, which application must be summit in person.

The requirements for foreigners who are living in the Czech Republic are:

- Passport
- Proof of the staying purpose
- Resources for the stay in the Czech Republic
- Proof of accommodation
- 2 photographs
- Proof of Health insurance
- Medical report certifying which certifies of non-serious disease

3.8.4 Foreigners by citizenship

CZSO data sets contains information about foreigners with a Long-term residence between the years 1994 - 2015. There are almost 194 different nationalities. The largest group of foreign nationals in the country are Ukrainians which is about 23%, followed by Slovaks at 22%, and Vietnamese at 12%. Then the Russians makes up just 8%, followed by Germany at 5% and Polish at 4%. The decrease of people coming from outside the European Union from 2009 - 2015 has stopped.

3.8.5 Foreigners by region and area

CZSO data set contains information about registered foreigners by area, region and district where they are residing in the Czech Republic in 1996 and between 2002 – 2015.

The Czech Republic is divided into **14 self-governing regions**. The capital and the natural political, economic and cultural center of the country is **Prague** (UNESCO monument). In 2015 there were almost 105% more foreigners than in 2004 when the country joined the European Union, exactly **171,408**.

Table 4 Foreigners by region

Region name EN	Region name CZ	Foreigners 2015
Prague	Hlavní město Praha	171 408
Central Bohemian Region	Středočeský kraj	61 682
South Bohemian Region	Jihočeský kraj	16 390
Plzeň Region	Plzeňský kraj	27 304
Karlovy Vary Region	Karlovarský kraj	19 073
Ústí nad Labem Region	Ústecký kraj	32 612
Liberec Region	Liberecký kraj	17 894
Hradec Králové Region	Královéhradecký kraj	13 683
Pardubice Region	Pardubický kraj	12 011
Olomouc Region	Olomoucký kraj	10 413
Moravian-Silesian Region	Moravskoslezský kraj	24 493
South Moravian Region	Jihomoravský kraj	40 366
Zlín Region	Zlínský kraj	8 538
Vysočina Region	Kraj Vysočina	8 050

Source: Directorate of Alien Police Service

3.8.6 Demographic events

Marriage

The application for a marriage license and all the details about the procedure can be obtained from the respective City Hall of the District Council. (Městský úřad, Obvodní úřad, Obecní úřad) or the local church.

The applicant must submit certified documents and must be translated into Czech language to the Czech local authorities.[10][15]

- **International Birth Certificate** in order to identify the birth date and place of birth, their name and surname, as well as documentation concerning their parents.
- **Passport** in order to identify the citizenship.
- **Death Certificate** of the spouse, if the applicant is widowed.
- If divorced, the **final divorce decree** granted by the court.
- **Certificate**, **legal document** or **testimonial** certifying the applicant's capacity to marry and certifying that no legal impediment exists in order to proof that both of them are free to marry. These documents are required in order to guarantee that the marriage entered into in the Czech Republic will also be recognized by law in the applicant's native country.
- Document certifying that the applicant is legally staying in the territory of the Czech Republic. This document is issued by the foreign police.

Marriage between Czech Nationals and Foreign Nationals

In order for a citizen of the Czech Republic “Female or Male” get married with a foreign national in the Czech Republic must prove his identity by providing the following documents: [11]

- Birth certificate
- Proof of Czech citizenship

- Extract from the Information System of Inhabitant Records of his/her place of the permanent residence
- Extract from the Information System of Inhabitant Records of his/her personal status

CZSO data set contains information about married foreigners in the Czech Republic in years 1995 – 2015.

Table 5 Marriages in years 1995 - 2015

Year	Male foreigner Czech female	Female foreigner Czech male	Both foreigners	Total
1995	1,839	771	61	**2,671**
1996	2,078	1,169	53	**3,300**
1997	3,131	1,927	58	**5,116**
1998	2,873	1,666	90	**4,629**
1999	2,793	2,060	90	**4,943**
2000	3,092	2,160	61	**5,313**
2001	2,672	1,691	54	**4,417**
2002	2,824	1,722	53	**4,599**
2003	2,788	1,859	69	**4,716**
2004	2,969	2,011	72	**5,052**
2005	2,652	1,822	96	**4,570**
2006	2,549	1,907	110	**4,566**
2007	2,845	1,940	184	**4,969**
2008	2,585	1,649	160	**4,394**
2009	2,374	1,803	192	**4,369**
2010	2,403	1,707	214	**4,324**
2011	2,384	1,722	250	**4,356**
2012	2,344	1,663	276	**4,283**
2013	2,370	1,473	243	**4,086**
2014	3,048	1,802	365	**5,215**
2015	3,016	1,802	352	**5,170**

Source: Czech Statistical Office

Divorces

CZSO data set contains information about divorced foreigners in the Czech Republic in years 1995 – 2015.

Table 6 Divorces in years 1995 - 2015

Year	Male foreigner	Female foreigner	Both foreigners	Total
1995	237	440	39	716
1996	241	500	47	788
1997	265	552	43	860
1998	308	614	41	963
1999	281	646	38	965
2000	315	643	46	1,004
2001	366	643	24	1,033
2002	432	735	37	1,204
2003	515	801	49	1,365
2004	568	902	53	1,523
2005	625	963	57	1,645
2006	717	1,069	86	1,872
2007	840	1,198	113	2,151
2008	831	1,268	118	2,217
2009	777	1,074	138	1,989
2010	790	1,197	197	2,184
2011	678	1,026	170	1,874
2012	665	1,032	203	1,900
2013	648	935	259	1,842
2014	656	942	296	1,894
2015	686	1,005	355	2,046

Source: Czech Statistical Office

Divorce procedure held in the Czech Republic might be long and complicated, due to the language barrier and necessary translations might be needed, however, it is easier in the sense that there is no obligatory separation period and the costs are generally lower than in other EU countries (June 2014, by JUDr. Anna van der Weerden).

There are two types of divorce in the Czech Republic, fault based (difficult) and no-fault based divorce.[12] [15]

- In case of **no-fault** based divorce, the entire procedure is significantly accelerated and simplified.
- In case of a **fault-based** divorce procedure where one of the married couple disagrees with the divorce, or when the partners are not able to arrange their mutual relations after the divorce.

Live Births, Deaths and Abortions

CZSO data set contains information about Live births, Deaths and Abortions of foreigners in the Czech Republic in years 1995 – 2015.

Table 7 Live Births, Deaths and Abortions in years 1995 - 2015

Years	Live births	Deaths	Abortions
1995	667	423	1,447
1996	651	305	1,778
1997	647	312	2,002
1998	939	317	2,356
1999	1,028	267	2,634
2000	1,036	285	2,476
2001	888	252	2,576
2002	1,154	247	2,751
2003	1,276	219	2,660
2004	1,352	231	2,254
2005	1,518	245	2,238
2006	1,725	281	2,285
2007	2,094	287	2,658
2008	2,666	299	3,252
2009	3,104	332	3,020
2010	3,034	356	2,659
2011	2,959	404	1,370
2012	3,270	561	2,319
2013	3,345	534	2,171
2014	3,482	560	1,955
2015	3,631	642	1,909

Source: Czech Statistical Office

3.8.7 Acquisition of Czech citizenship

The acquisition and loss of Czech citizenship is mainly regulated by the **Act No. 40/1993 Sb**. In addition, certain cases are handled according to the **Act No. 193/1999 Coll.,** on the Citizenship of Certain Former Czechoslovak Citizens, which is specifically targeted at former Czechoslovak citizens who were deprived of Czechoslovak. They can get Czech citizenship by declaration and without the obligation of residence. Moreover, rules for Slovak citizens were eased after the dissolution of Czechoslovakia and even now they can get Czech citizenship by declaration if they have been factually staying in the Czech Republic since 1993.

Czech citizenship can be acquired in several ways. The most common are:

Through birth: children are automatically a Czech citizen once being born if at least one of the parents are either a citizen of the Czech Republic or has permanent resident in the Czech Republic.

By granting: If the foreigner meets all of the following criteria the Czech citizenship can be awarded by the Ministry of the Interior:

- For at least five years they have had a permanent residence in the Czech Republic. It means most of the time they have been in the Czech Republic.
- They have not been lawfully sentenced for an intentional crime in the Czech Republic in the last 5 years.
- They have to demonstrate knowledge of the Czech language. This requirement can be waived by the Ministry of the Interior. E.g. due to the applicant's advanced age or health status.
- They fulfils obligations stipulated by the **Foreigners Act** in the field of health insurances, social security, taxes and levies.

The number of foreigners who apply for Czech citizenship since the last year is growing constantly. In 2016 the number doubled in comparison with the previous year. One of the reasons according to the citizenship law of the Czech Republic (**Act No. 186/2013 Coll**.) is that people can now have two citizenships.[13]

In the past there was a strict requirement in order to acquire Czech citizenship an individual must give up their other citizenship. Czech citizenship is granted more frequently to citizens of Ukraine, Slovakia, Russia and Viet Nam.

The second reason is a simple procedure which has an effect for young adults. The only condition is that they came to the Czech Republic younger than 10 years old.

CZSO data set contains information about Czech citizenship acquired per year in years 2001 – 2014.

Table 8 Acquisition of Czech citizenship in years 2001 - 2014

Year	Act No. 193/1999 Sb.	Act No. 40/1993. and Act No. 186/2013	Total
2001	1,607	4,714	6,321
2002	1,273	3,259	4,532
2003	1,154	2,256	3,410
2004	1,784	3,236	5,020
2005	190	2,436	2,626
2006	205	2,141	2,346
2007	225	1,652	1,877
2008	229	1,608	1,837
2009	173	1,448	1,621
2010	171	1,324	1,495
2011	144	1,792	1,936
2012	140	1,896	2,036
2013	134	2,380	2,514
2014	22	5,092	5,114

Source: Ministry of the Interior

3.8.8 Illegal migration

Foreign Police is a special division within the Czech Republic Police force, they primarily performs tasks related to detect illegal migration and implementation of repressive measures against foreigners staying in the Czech Republic in contravention of the Foreigners Act. The foreign police offices in the Czech Republic are applicable for legally residing foreigners for the purposes of:[14]

- Reporting their place of residence in the territory of the CR in time limits specified by Law.

- Invitation verification.
- Issuance of short-term residence certificate or certificate of the legitimacy of residence in the territory (e.g. for the purpose of marriage).
- Extension of the residence period in the territory for a short-term visa.
- Control of the residence legitimacy in the territory.

There are two basic categories of illegal migration:

Illegal crossing of the external Schengen border of the Czech Republic

This category includes foreigners and citizens of the Czech Republic crossing or attempting to cross illegally through the external Schengen border (international airport) of the Czech Republic. Since 2008 the border control has been made only at the external Schengen borders. The state borders with the neighbor countries (Austria, Germany, Slovakia and Poland) have become an internal Schengen border and thus the data referring to illegal migration across the state border cannot be compared.

Illegal stay

This category is for foreigners who have violated the conditions required by law that regulates their stay in Czech territory, including transit areas at international airports. From 2008 the category of illegal stay includes persons that have entered the territory of the Czech Republic from neighboring countries without necessary requisites for staying in the Czech Republic**.** CZSO data set contains information about illegal migration of foreigners in the CR in years 2008 – 2015 and data up to 2008.

Table 9 Illegal stay in years 2008 - 2015

Years	Across the state borders	Illegal stay	Total
2008	4,023	168	3,829
2009	10,572	190	4,457
2010	10,573	140	2,987
2011	2,011	80	3,360
2012	2,252	119	3,595
2013	2,253	179	4,153
2014	2,014	181	4,822
2015	2,061	240	8,563

Source: Directorate of Alien Police Service MI CR

The following table shows the total number of illegal stay in the territory of the CR by citizenship in years 2008 - 2015 which includes:

- At border crossing when leaving the CR.
- At control and security operations
- Others, and in the Czech territory

Table 10 illegal stay by citizenship in years 2008 - 2015

Nationality	2008	2009	2010	2011	2012	2013	2014	2015
Ukraine	1547	1502	953	1123	1064	888	1020	1224
Russian Federation	190	376	261	346	419	512	381	358
Viet Nam	316	389	310	341	380	311	301	229
Mongolia	269	253	139	115	97	97	-	-
Slovakia	-	224	135	137	118	197	129	99
Kuwait	-	-	-	-	54	255	450	588
Libya	-	-	-	-	-	296	406	135
China	79	87	70	69	110	88	71	-
Moldova	97	140	97	87	83	59	-	-
Armenia	98	80	59	87	77	85	-	-
Georgia	94	163	-	72	64	46	-	-
Uzbekistan	-	88	40	60	85	69	59	-
Saudi Arabia	-	-	-	-	45	109	231	258
Kazakhstan	-	61	32	58	60	64	59	-
Belarus	83	80	61	49	57	-	-	-
Turkey	43	49	43	47	-	55	55	-
Kosovo	-	-	-	-	-	-	183	264
Nigeria	49	73	58	-	-	-	-	-
Syrian Arab Republic	-	-	-	-	-	-	142	2016
Afghanistan	-	-	-	46	-	-	63	583
Kyrgyzstan	-	50	45	-	-	-	-	-
India	-	-	-	-	-	-	70	94
Serbia	50	-	-	-	-	-	-	-
United States	-	-	-	-	47	-	-	-
Libanon	-	-	-	41	-	-	-	-
Macedonia	39	-	-	-	-	-	-	-
Not identified	35	-	-	-	-	-	-	
Egypt	-	-	31	-	-	-	-	
Iraq	-	-	-	-	-	-	-	403
Pakistan	-	-	-	-	-	-	-	276
Bangladesh	-	-	-	-	-	-	-	134
Cuba	-	-	-	-	-	-	-	94

Source: Directorate of Alien Police Service

3.8.9 Education

Foreigners that rightfully reside in the Czech Republic have access to pre-primary, primary, secondary and vocational education under the same conditions as

citizens of the Czech Republic. Education is organized within a school year which begins on the 1st September and ends on the 31st August of the following calendar year. The school year is divided into the period of teaching and the period of school holiday. The teaching period begins on the 1st September and ends on the 30th June of the following calendar year (exact date may vary with respect to the nearest work day or other circumstances) and it is sub-divided into two half-years. The period of school holidays consists of autumn holidays, Christmas holidays, half-year holidays, spring break, Easter holidays and the main holidays. Teaching takes places in a five-day teaching week. Public administration in education, for developing educational, youth and sport policies and international cooperation in these field are under the responsibility of The Ministry of Education, Youth and Sports (MEYS, MŠMT in Czech). [16]

CZSO provides information in Excel and PDF format about foreigners in the following type of levels:

- All type of schools
- Secondary schools
- Higher professional schools
- Universities

3.8.10 Employment

The Labour Office of the Czech Republic is established by **Act No. 73/2011 Coll.** Act on the Labour Office of the Czech Republic and amending related laws". The Labour Office "Úřad práce" is responsible for all areas of employment and protection of workers.

Foreigners holding trade license

In accord with the Trade Licensing Act No. 455/1991 Sb., as amended, foreigners are allowed to do business in the CR like any Czech citizens, if they fulfill obligations as set down in mentioned Act and related regulations. They are allowed to carry on their business activity according to the Trade Licensing Act as natural persons, but they can also establish legal persons in the CR (usually business companies or cooperatives according to the public registers), or found on the territory of the CR organizational

units of their enterprises abroad. According to the Trade Licensing Act, the foreign natural person is a natural person, who does not have residence (i.e. permanent residence) on the territory of the Czech Republic. This person must hold a residence permit to stay in the Czech Republic in accordance with the Act No. 326/1999 Sb., unless it is a national of an EU Member State or a citizen of a state with which the CR concluded a treaty banning this restriction. This provision thus applies also to nationals of states, which are bound by an international treaty concluded with the European Communities, as well as to nationals of states, which are bound by the EEA Treaty. [17]

3.9 Ministry of the Interior of the Czech Republic

The Ministry of the Interior provides an updated Excel file once a week, which contains all approved applications for *temporary*, *long-term* and *permanent* residencies and *employee cards* in Czech Republic. [18]

3.10 Otevrenedata.cz

This website reports on current trends and possibilities of working with the data. Its aims to promote wider use of Open Data in the Czech Republic. It manages the Open Data of *Fond Otakara Motejla*, of which its aim to be an effective public administration, supported by an active civil society.[19]

3.11 NADACE Open society fund

The Open Society Fund of Prague supports the development of an open society and promotes systemic changes that will help to strengthen democracy in the Czech Republic. It is a part of the international network called the Open Society Foundations, which was founded by American investor and philanthropist George Soros and as of today is active in more than 70 countries around the world.

OSF Prague encourages non-governmental and non-profit organizations, civic initiatives, and individuals to actively influence conditions in their region and country. The foundation conducts open calls, for proposals through which is distributing grants for promoting human rights, transparency, education, and other areas that can help to develop the open and democratic society. Between 1992 and 2011, OSF has distributed more than 1.2 billion CZK for more than 9,200 projects.[20]

3.12 Data blog Cz

Data blog CZ is a platform for creative work with information, which monitors journalism, Open Data, e-democracy, and openness of public administration and online activism.[21]

3.13 Benefits of Open Data

The main advantages are provided by the possibility of companies that can produce economic value by using the data published by the Public Administration, and creating a new services and applications using open data set. Open data can be very useful in the following areas:

- **Cultural** for work and artifacts. For example; galleries, libraries, archives and museums are the main sectors where titles and authors that are held and collected.
- **Science** in this area can be used to produce scientific research which can be useful for a vast number of areas (astrophysics to zoology etc...)
- **Finance** could involve data from public entities accounts about their expenses and revenues and also information on financial markets.
- **Statistics** this kind of data is produced by statistical offices such as: CZSO which is used for the purpose of this thesis.
- **Weather** in order to predict the weather and climates changes there are many types of information used to understand them.
- **Environment** involves environment information such as: earthquakes, tsunami, presence and level of pollution, and the quality of rivers etc.
- **Transport** involves data such as time schedules , routes, on-time statistics etc.
- **Investors** are used to analyze the risks and rewards of different companies in their search for the best opportunities.

Open data is also being used by many professionals in their respective area in order to obtain more productivity.

- **Company owners** are used to understand subtle clues to their brand's reputation and to develop data-driven marketing strategies.
- **Entrepreneurs** are using Open Data on weather, housing, transportation and more to build businesses that provide new services and benefit the public.
- **Medical researchers** are using it to find treatments and cures for diseases more rapidly.

3.14 Applications using Open data

3.14.1 In the Czech Republic

Below are some examples of applications that use Open Data developed by Opendata.cz such as:[22]

vysledkykontrol.cz this web application contains data linked to the business registry made by Czech inspection authorities. Results are shown using Google mapping and Google geocoding to determine the coordinates where the inspection took place.

mapazakazek.cz the app shows public contracts, contracting authorities and suppliers on a map and computes a basic statistics for each contracting authority and supplier.

Hospodaření obcí the app shows budgets (financial incomes and outcomes) of Czech municipalities and regions. Which provides different statistics and comparisons.

Czech Crime is a non-profit, non-governmental initiative of *Otevřená společnost, o.p.s*. Czechcrime.org was made by *Geographisc.cz* and has been supported by *Think Tank Fund* program from the Open Society Foundations.

Status of your Visa this application was developed with the contribution of the Department of Information Technologies FEM CULS Prague and Czech Society for Information Technology in Agriculture in 2015 as my bachelor thesis. This application helps foreigners to check if their visa application is already approved or not by using only the receipt number instead of searching manually after downloading the Excel file, making the searching process faster and easier.

3.14.2 In the Union Europe

Below are some examples of applications developed by the European Institutions, agencies and other bodies as well as third parties. All are free of charge and are using open data.[23]

- **Open-H2020 observatory** is based on open data. Through an interactive map allows viewing projects, getting a general idea of their subject matter and seeing partnerships and geographical distribution. Published on 17/03/2017.
- **Sketch Engine** is a tool that helps you explore how language works. It analyses real texts ('text corpora') of billions of words to see how often words are used and what is rare, unusual or emerging usage. Useful for linguists, lexicographers, editors, translators, students, teachers and publishers, Sketch Engine contains 400 ready-to-use corpora in 85+ languages, each with up to 20 billion words. Published on 15/02/2017.
- **Energy modelling tool** is an interactive graph tool, displaying data from the EU Reference Scenario. It projects the impact of current EU policies on energy, transport and climate action trends. Projections cover five-year periods until 2050 for the EU as a whole and for each EU country. Published on 01/02/2017.
- **Politix EU** it describes in plain and simple language proposed EU laws, giving their background info and the key interest groups involved. It also provides a detailed list of lobbyists, a blog and a newsletter. Published on 15/02/2017.
- **The Eurostat Country Profiles** cover a wide field of high interest country indicators which range from population and living conditions, labour, health and safety, education, economy and finance, business information, environment, energy, and the information society. Published: 10/04/2013.
- **Natura 2000** is an ecological network of protected areas, set up to ensure the survival of Europe's most valuable species and habitats. Published: 10/04/2013.

- **The European Atlas of the Sea** is a user-friendly way for students, professionals and anyone interested to learn more about Europe's seas and coasts, their environment, related human activities and European policies that concern the sea. Published: 16/12/2013.
- **Young Europeans is a tool** which is primarily designed for young people aged 16-29. It provides the possibility to compare yourself with other young men and women in your country. Published: 15/12/2015.
- **Tendertracking** the aim of this portal is to make public spending in Hungary, Romania and Poland more publicly accountable. Published: 17/06/2016.

On the official page of European Union Open Data Portal can be found more applications that make uses of open data.

3.15 Software Development Process

A software development process, also known as a Software Development Life Cycle (SDLC), which is a structure imposed on the development of a software product. A software process is represented as a set of work phases or activities, methods, practices, and transformations that people use to develop and maintain software and the associated products. The software development process is not unique thus there is not an effective universal software process for all contexts of development projects. Because of this diversity it is difficult to automate a whole process of software development.

There are many different software processes but all must include four activities which are fundamental to software engineering:

Software specification The functionality of the software and constraints on its operation must be defined.

Software design and implementation The software being produced must to meet the specification needed.

Software validation The software must be validated to ensure that it does what the customer wants.

Software evolution The software must evolve to meet changing customer needs.(Sommerville, 2010). [24]

Furthermore of those core activities, there are a set of "protective activities" which are applied throughout the software process such as: (Pressman, 2010)

- Monitoring and Control of software project.
- Formal technical reviews.
- Software quality assurance.
- Software configuration management.
- Training and documentation.
- Reusability management.
- Measurements (process, project and product)
- Risk management

Generic process framework for software engineering encompasses five activities:

Communication. Involves communication among the customer and other stockholders; encompasses requirements gathering

Planning establishes a plan for software engineering work; addresses technical tasks, resources, work products, and work schedule.

Modeling encompasses the creation of models to better understand the requirements and designs.

Construction is an activity that combines code generation and testing is required to uncover errors in the code.

Deployment is a software which is delivered to the customer who then evaluates the delivered product and provides feedback based on the evaluation.

A process model for software engineering is chosen based on the nature of the project and application which decides on different methods, tools to be used and the controls

and deliverable that are required. There are many development life cycle models that have been developed in order to achieve different required objectives.

These generic models are not definitive descriptions of software processes. Rather, they are abstractions of the process that can be used to explain different approaches to software development.(Sommerville, 2010).[24]

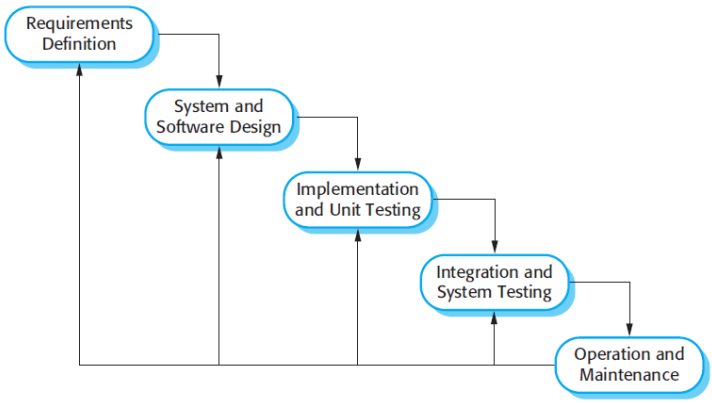
The following models can be considered as generic process which can be used to describe different approaches to software development such as:

3.15.1 Waterfall model

Commonly known as a *linear-sequential life cycle model*, is very simple to understand and use. It describes what development is to be carried out in a downward spiral like a water falls. Before a new phase can begin the previous phase must be completed, that means the process cannot be reverted back to the previous step to perform any changes. Small projects where requirements are well understood the waterfall model is found to be most successful.

The principal stages of the waterfall and its fundamental development activities is represented in the following figure.

Figure 6 Waterfall model



Source: (Sommerville, 2010)

Requirements analysis and definition The system's services, constraints, and goals are established by consultation with system users. They are then defined in detail and serve as a system specification.

System and software design The systems design process allocates the requirements to either hardware or software systems by establishing an overall system architecture. Software design involves identifying and describing the fundamental software system abstractions and their relationships.

Implementation and unit testing During this stage, the software design is realized as a set of programs or program units. Unit testing involves verifying that each unit meets its specification.

Integration and system testing The individual program units or programs are integrated and tested as a complete system to ensure that the software requirements have been met. After testing, the software system is delivered to the customer.

Operation and maintenance Normally (although not necessarily), this is the longest life cycle phase. The system is installed and put into practical use. Maintenance involves correcting errors which were not discovered in earlier stages of the life cycle, improving the implementation of system units and enhancing the system's services as new requirements are discovered. (Sommerville, 2010).[24]

Advantages:

- Simple and easy to understand and use, because phases are clearly defined.
- Works well for smaller projects.
- Phases are processed and completed one at time and do not overlap.
- Process and results are well documented.

Disadvantages:

- Main one is if there are any faults that occurs after the product is developed, the fixing cost to such issues could be very high, because it is necessary to update all the projects.
- Long and ongoing projects this model is not the best option
- In order to produce working software the whole process of the life cycle must be completed.

- Cannot accommodate changing requirements.

3.15.2 Spiral model

Combines the idea of iterative and waterfall model, but basically with more emphasis placed on risk analysis and is most useful for large projects. Each phase in spiral model begins with a small set of requirement and goal, which goes through each development phase to complete the requirement needed. It includes the following phases

Planning is the begining phase which starts with gathering the business requirements in the baseline spiral, and also it envolves continuous communication between the system analyst and the customer and also includes estimating the cost and resources.

Risk analysis focuses on alternate solutions and detection of potential risk which may occur, while risk mitigation strategy is planned and finalized.

Engineering basically consist on testing, coding, design document and deploying software at the customer site.

Evaluation software is evaluated by the final customer in order to ensure that the product meets all their requirements, and also, includes identifying and monitoring risks such as schedule slippage and cost overrun.

Advantages:

- Best approach for complex project.
- Customer evaluation can make this model more useful.
- Useful if requirements are changing frequently.
- Better risk analysis and management.

Disadvantages:

- Doesn't work well for smaller or low risk projects.
- Spiral may go indefinitely making the end of project and cost unknown.
- Large number of intermediate stages requires excessive documentation.

3.15.3 Iterative model

The basic idea behind this method is to develop a system through repeated cycles called "interactions" and in smaller portions at a time until a fully functioning software is ready to be delivered to production. Working through iterations means that the development of the application is split into smaller chunks/subsets. In each iteration features are defined, designed, developed and tested.

This model is kind of similar with the waterfall model regarding to the phases because each phase of the software development life-cycle (SDLC) needs to be fully completed until the next one can start.

Advantages

- More flexibility to adapt to changes.
- Requirements of the complete system are clearly defined.
- High priority risks are taken in the first iteration so at the end of the project risk at the minimal, it enables early user feedback making easier to spot problems before it is too late or too expensive to take corrective actions.
- Results are obtained early and periodically.

Disadvantages:

- No suitable for smaller projects.
- More resources may be required.
- Each phase on an interaction is rigid with no overlaps.

3.15.4 Incremental model

The basic idea behind this method is that the project requirements are divided into multiple development modules to be developed separately an making more easily to work with, the developed modules are integrated with the other modules. Each module goes through the requirements, design, implementation and testing phases and each working module gets delivered to the end users one after another. The product is defined as completed when it satisfies all of its requirements.

Advantages:

- Initial product delivery is faster with a lower cost.
- Customer can respond to feature and review the product.
- Easier to test and debug during a smaller iteration.
- With each release a new features is added to the product.

Disadvantages:

- Resulting cost may exceed the cost of the organization and its higher than waterfall.
- Needs good planning and design before starting the project.

3.16 System Development Life Cycle

The SDLC process was designed to ensure end-state solutions to meet user requirements to support of business strategic goals and objectives. There are several models for such processes which were defined above, and all of them take a project through several phases such as: requirements, design, implementation, testing, deployment and maintenance. Each phase produces their results which are required for the next phase in the life cycle.

Requirements

The first step of any system's life cycle. During this phase, the objective of the project is determined and all the requirements to produce the product are considered, including the resources such as personnel and cost. The risks and various project-planning are defined considering the strengths and weakness of the project.

Design

In this phase the physical system and software design is prepared from the requirement specifications which were considered in the previous phase. For the user interface, the project team designs mock-up screen layouts, business rules, process diagrams and other documentation which determines how the program will function and how it is used by

the developers and software engineers to develop and deliver the system based on this information with minimal changes.

Implementation

In this phase the whole work is divided in to smaller modules or units which help developers execute the plans laid out in the design phase. Smaller projects may involve a single programmer, while larger projects may include multiple teams working together. Once the software is developed, the stage of implementation comes in where the product goes through a pilot study to see if it's functioning properly

Testing

This stage of the SDLC involves bringing the separate modules of the project together into a dedicated testing environment to check bugs, error or other issues in the developed software in order to make sure that the product is actually solving the needs addressed and gathered during the requirements phase.
In this phase there are implements of different types of functional and non-functional testing such as:

- *Integration testing* consists of individual units or modules which are combined and tested as a group.
- *Unit testing* is where individual units or components of software are tested.
- *System testing* is a complete and fully integrated software test.
- *Acceptance testing* is a system which tests for acceptability

Deployment

Once the system is error-free, it is ready to be delivered to the customers. This is where the customer performs their first beta test in order to review the product for any bugs or errors. If there is any bugs found the program it's immediately fixed, then the final deployment can begin.

Maintenance

The final stage of SDLC occurs once a program has passed the testing phase and the system becomes fully operational. The key objective is that the system is kept live and

working in the real-time environment, which means that the system will be maintained and upgraded from time to time to adapt to changes.

In conclusion, SDLC is a key factor and plays an important role in the development phase of a product ensuring quality software is developed in a controlled environment that meets the expectations of the customer.

3.17 Technologies

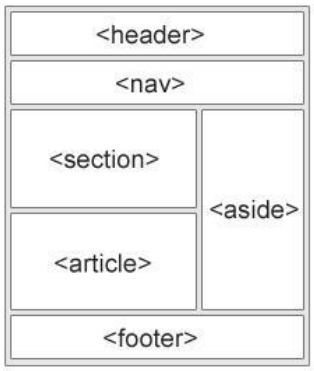
3.17.1 HTML5

Is a markup language used for structuring and presenting content on the World Wide Web. It was published in October 2014 by the World Wide Web Consortium (W3C) to improve the language with support for the latest multimedia, while keeping it easily readable by humans and consistently understood by computers and devices such as we browsers.

The HTML5 syntax is no longer based on **SGML,** but is instead a markup language all on its own. It comes with a new introductory line that looks like an SGML document type declaration, *<! doctype html >* which is very simple and streamlined.

New semantic and structural elements. Figure 9.

Figure 7 HTML5 Semantic Elements



Source: w3schools

In general, all pages have a basic structure such as: navigation, body content, and sidebar content plus headers, footers, and other features. And HTML 5 has created new semantic elements “tags“ to support those elements of the page.

- <main> - defines the main content of the page, and it's unique.
- <section> - defines sections a section in a page.
- <header> - defines the header of a page.
- <footer> - defines the footer of a page.
- <nav> - defines the navigation on a page.
- <article> - defines the article or primary content on a page.
- <aside> - defines extra content like a sidebar on a page.
- <figure> - defines images that annotate an article.

The most interesting new elements are:

- <canvas> - an element is used to draw graphics on the fly using JavaScript. However, allows also adding images to dynamic graphs on web pages.
- <video> - using this simple tag allows to add video.
- <audio> - using this simple tag allows to add sound.

HTML5 is supported in all modern and old browsers. With HTML5, developers can easily create more useful forms using the new attributes such as: datetime, datetime-local, date, month, week, time, number, range, email and url.

However, while HTML5.1 is planned to bring some handy improvements (mainly to the canvas), basic HTML5 is the new standard web developers now need to work to, and it will remain in place for many years to come. In addition, HTML5 includes numerous other enhancements such as geolocation handling, web workers to manage background tasks, improved form handling, access to bundles of local storage (far in excess of the limited capabilities of cookies), and even the facility to turn web pages into web applications for mobile browsers. (Robin Nixon, 2015). [25]

3.17.2 CSS3

Cascading Style Sheets (CSS) is the language for describing the presentation of Web pages, including colors, layout, and fonts. It allows one to adapt the presentation to different types of devices, such as large screens, small screens, or printers. CSS is

independent of HTML and can be used with any XML-based markup language. The separation of HTML from CSS makes it easier to maintain sites, share style sheets across pages, and tailor pages to different environments. (World Wide Web Consortium, 2010).[26]

CSS3 is the latest evolution of the *Cascading Style Sheets* language and aims at extending CSS2.1. Helping developers solve a number of problems without the need for non-semantic markup, complex scripting, or extra images.

CSS3 has been split into "modules". Some of the most important CSS3 modules are:

- Selectors
- Box Model
- Multiple backgrounds and Borders
- Image Values and Replaced Content
- Text Effects
- 2D/3D Transformations
- Animations
- Multiple Column Layout
- User Interface

CSS3 has advanced selectors helping to find elements like odd and even rows of tables, all selected checkboxes, or even the last paragraph in a group. This also makes it much easier to style HTML code.

CSS3 provides two new methods for performing animations:

- **Transitions** allows to state a property to gradually change from one value to another.
- **Animations** allows to get more specific, defining keyframes for complex animations.

3.17.3 JavaScript

JavaScript (JS) is a programing language, primarily used in web development, enabling to enhance HTML pages and is commonly found embedded in HTML code within <*script*> tags or when specific events take place. Source code in JS is processed by the client's web browser rather than on the web server. This means JavaScript functions can run after a webpage has loaded without communicating with the server.

Developers using JS develop more dynamic web pages allowing users to interact with web pages by changing text, validating text in forms to make sure required fields have been filled, creating pop-up messages, because it allows developers to manipulate the web page elements. While HMTL allows web developers to format content.

3.17.4 Highcharts

Highcharts offers an easy way of adding an interactive charts to a web application, which supports various of dynamic and interactive charts such as line, spline, area, areaspline, column, bar, pie, scatter, angular gauges, arearange, areasplinerange, columnrange, bubble, box plot, error bars, funnel, waterfall and polar chart types, which is written in pure JavaScript.[27]

The key features are:

- *Pen source* this mean that under any of the licenses, free or not, developers or any users are allowed to download the source code and make their own edits. This allows for personal modifications and a great flexibility.
- It works in all modern mobile and desktop browsers including the iPhone/iPad.
- *Simple Configuration Syntax* it not require special programming skills
- *Dynamic*, Easy to add, remove and modify series or axes at any time after chart creation.
- *Multiple axes* allows to add “y” for each series or “x” axis in order to compare data sets of different categories.
- *Tooltip labels* allows to add information on each point and series.

- *Zooming* by zooming in on a chart you can examine an especially interesting part of the data more closely.
- Polar and inverted chart.
- Text rotation for labels.

3.17.5 CEZET Map

Developed by Moravio.com is a character font, which makes easy to create a map of the Czech Republic using HTML and CSS. The entire map is developed using scalable fonts which allows changes by using CSS styles. [28]

JavaScript is required to display the map in modern browsers.

Adds external CSS files:

- *CEZET Map.css* contains basic styling.
- CEZET Map.custom.css is reserved for user customization.

4 Practical Part

4.1 Introduction

In this section, it will be explained in detail the whole process of designing and developing of the system called *"Foreigners in the Czech Republic"*[29] by using the open data set from Czech Statistical Office (CZSO) and thus be able to show how powerful and useful open data is, for the benefit of the community, municipalities, companies, small/medium/large sizes business, tourists or anyone who can find it useful.

"Foreigners in the Czech Republic" will be a user-friendly web application which supports Desktop, Tablets and Mobile phones because it will be developed using a responsive design. In this generation everyone is using smaller devices (tablets, phones etc.) instead of a traditional desktop computer this is why responsive design will be used.

The following examples are a few ideas of this application could be useful:

- A family, who wants to move to Prague, might have an expectation of a location where they would like to live with more/less foreigners.
- Someone might be interested in knowing the statistics of a foreigner marriage to a national or vice versa.
- The owner of a restaurant would like to offer an extra menu on weekends dedicated to foreigners, so he/she would like to have the accuracy statistic that in the region or area where the restaurant is located are many foreigners.
- A person that is moving to the Czech Republic for work purpose they would like to know the percentage of foreigner that have obtained residence after 5 years working in the Czech Republic.

The web application will be developed using HTML5, CSS3, JavaScript, CEZET Map in order to use a map of the Czech Republic in a dynamic way and using the Highcharts JS to create a meaningful charts. For example the total number of registered foreigners residing in different regions and areas of the Czech Republic between the years 1993 - 2015.

A database was not needed, because CZSO provides the data in Excel and PDF format which belongs to the lowest level of open data according to the five star system. The data will be downloaded in Excel Format, which will be entered directly into Highcharts JS scripts.

4.2 Open data of Czech Statistical Office

CZSO provides statistics of all the country in almost 35 areas (Table 2) and one of those areas is focused on registered foreigners residing in the Czech Republic which are provided in Excel and PDF format. Finding a specific statistics about foreigners in dynamic tables and graphs can be very complex to obtain, because CZSO provides exactly 8 dynamic tables about foreigners which only a few of them have a chart view. But more statistics about foreigners can be found among other areas, which can make the search process longer and complex. Another option to obtain specific statistics is to download Excel file, But a good command of Excel skills will be needed to produce meaningful charts otherwise the data could be difficult for understanding.

To help develop this application the following areas about foreigners were chosen:

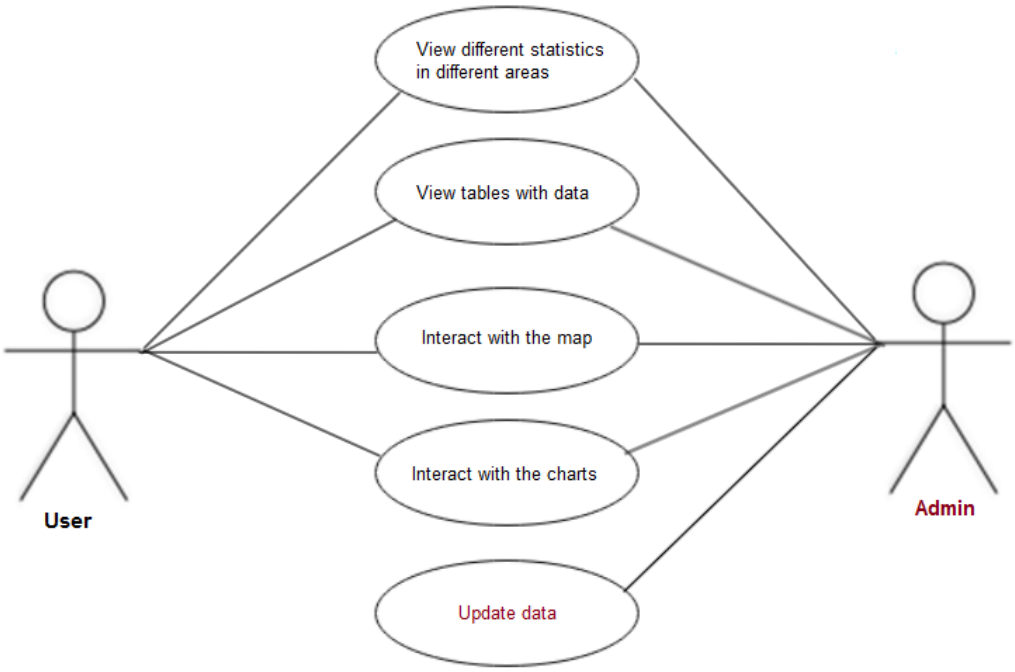
- Foreigners
  - By type of residence, By regions, Citizenship and Top 6 countries
- Demographic events
  - Marriages, Divorces, Abortions, Deaths and Births.
- Acquisition of Czech citizenship
- Employment
- Education
  - By type of school, University and Higher schools
- Illegal migration

Statistics on foreigners are processed within the framework of policy for Integration of immigrants, which is updated every year on a Decision of the Government of the Czech Republic.

4.3 Usecase Diagram

A unified modeling language (UML) was created, in order to show the actions that the users can perform on the developed system *"Foreigners in the Czech Republic"*.[29]

Figure 8 Usecase Diagram of the application



There are just two actors.

User: Can perform the following actions:

- View different statistics in different areas about foreigners
- View tables with data according to the region and area
- Interact with the charts
- Interact with the map

Admin: Can perform all actions of the user, but is the only person who can make changes to keep the system updated.

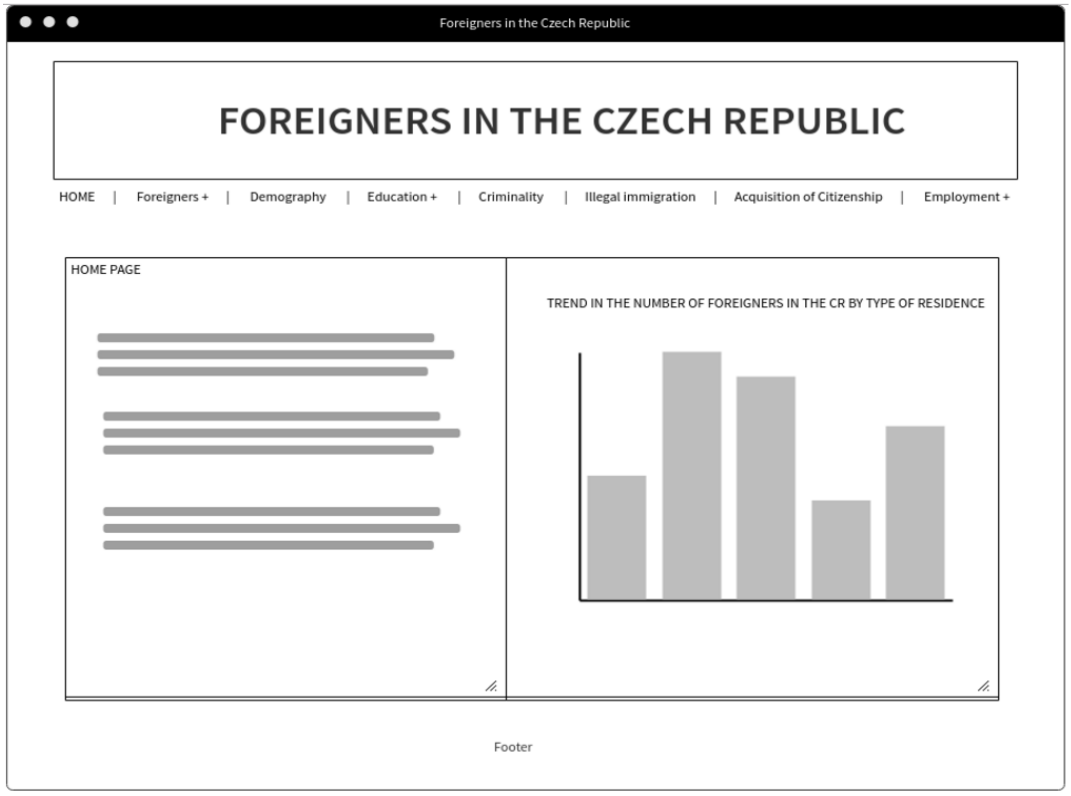
4.4 Wireframes

Before developing the website it was considered important to make it available over multiple devices which should not be overlooked. Responsive design is forcing to re-think about how to plan out the site designs and how pages gracefully fits the device that the users will use such as Desktop, Table and Mobile phone. Using Wireframes will help in the design process to determine which elements such as tables, graphs and map should be included in each page.

Wireframes will be designed for the following pages such as Home page which will contain Total number of foreigners by type of residence. The second menu Foreigners which has three sub-menus. Table and Mobile phone. The other pages like Education, Criminality, Illegal migration, Acquisition of citizenship and Employment will use the same wireframes design with different data.

The home page will be the first page which the users will see on the website which is represented in the first wireframe design. See below, figure 11.

Figure 9 Home page design



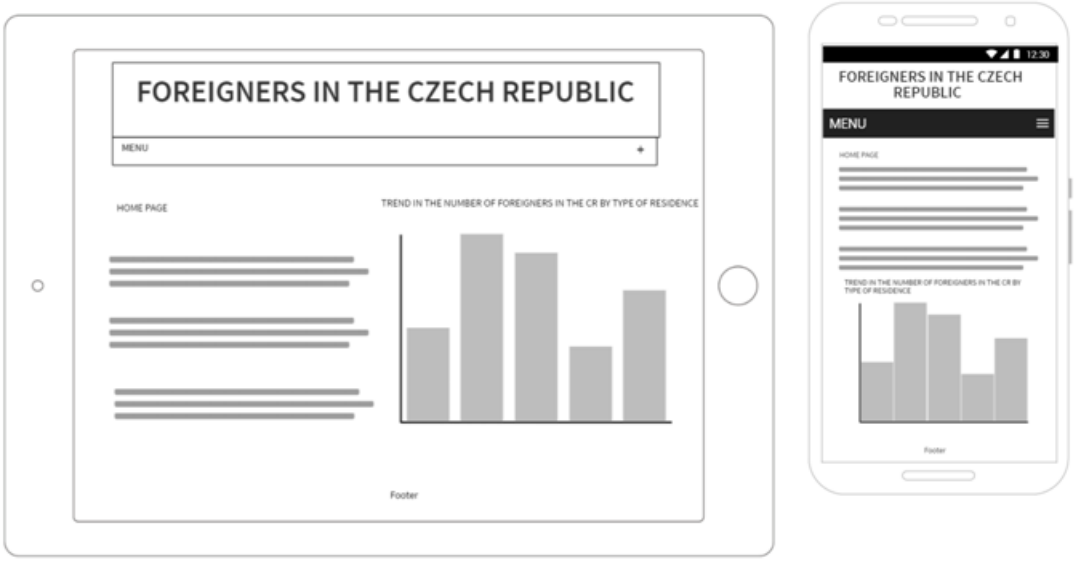
Source: own

The layout of the home page is divided in to the following parts:

- Head for the main title of the page.
- Navigation bar, includes all the pages of the application which will allow users to navigate into the pages and sub-menus.
- The body part is divided into two parts. As it can be seen above in the figure 11. On the left side will be an interpretation about the right side chart which will show the total of registered foreigners in the Czech Republic by type of residence.

In the following figure, there are the Tablet and Mobile phone wireframes of the home page. As it can be seen the navigation bar in both of them have a dynamic drop down menu and according to the size of the device, the left side information appears first followed by the right side graph, because of Responsive Web Design was used to developed the application.

Figure 10 Home page, Table and Mobile design



Source: own

Next wireframe design represent the sub-menu "By regions" which is part of the foreigners menu. The body of this page is divided into two rows and each row has two columns.

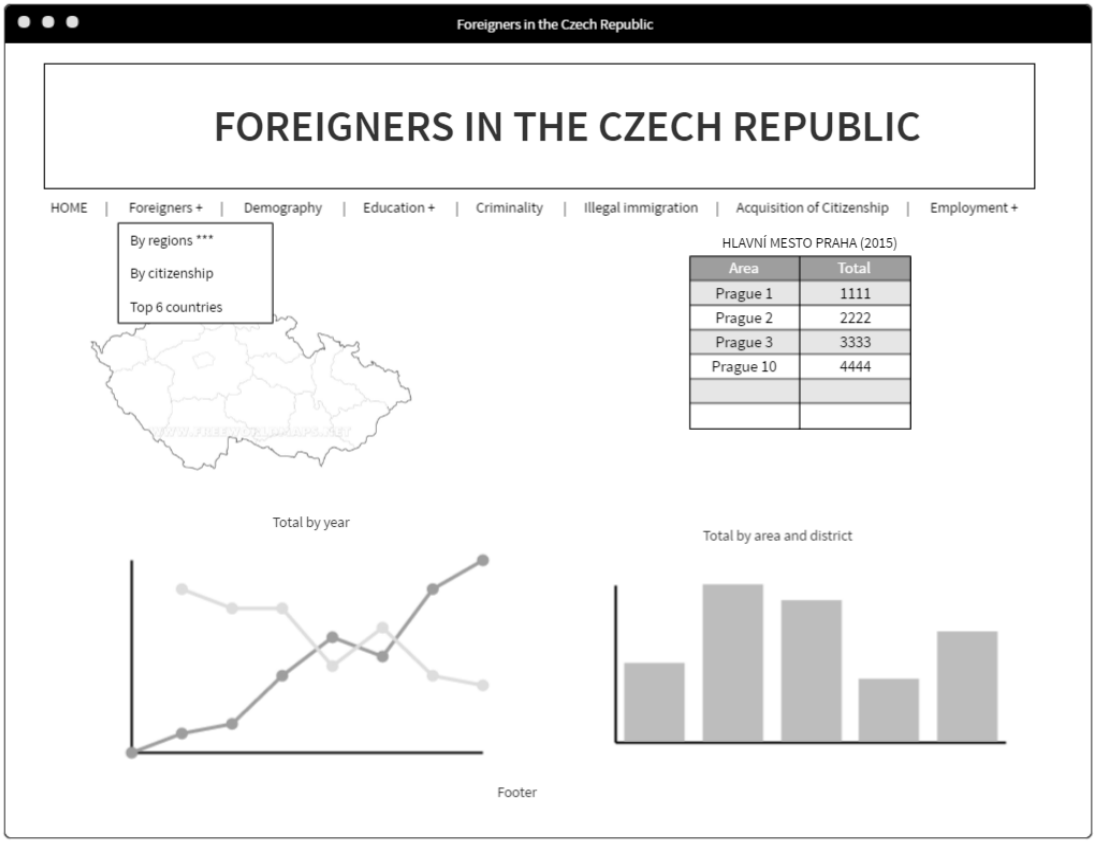
First row - first column will be a dynamic map of the Czech Republic. As it was mentioned, the Czech Republic is divided into 14 regions. To help users to quickly access statistics, the Table, Bar and Line charts will change by clicking on a specific region.

First row - second column will be a table which contains the total number of foreigners living in each area of the chosen region in the year 2015.

Second row - first column will be a Line chart which shows the total number of foreigners by years in a chosen region between the years 2002 - 2015.

Second row - second column will be a Bar chart which shows the total number of foreigners by area in a chosen region between in the years 2002 - 2015. Users will be able to interact with the Bar chart in order to make comparison with other areas.

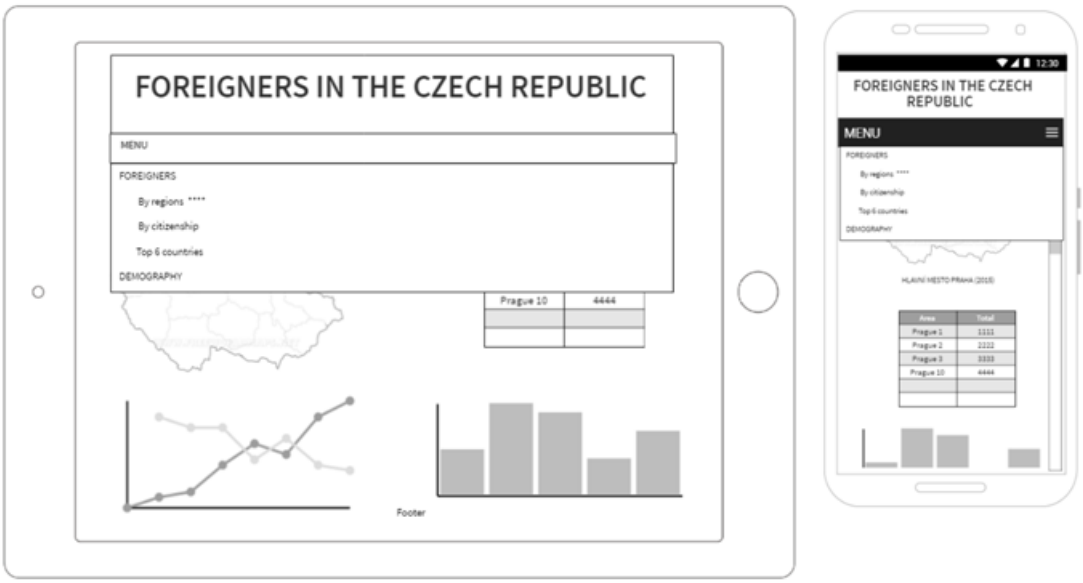
Figure 11 Foreigners by region design



Source: own

The following figures are Tablet and Mobile phone wireframes of the previous page.

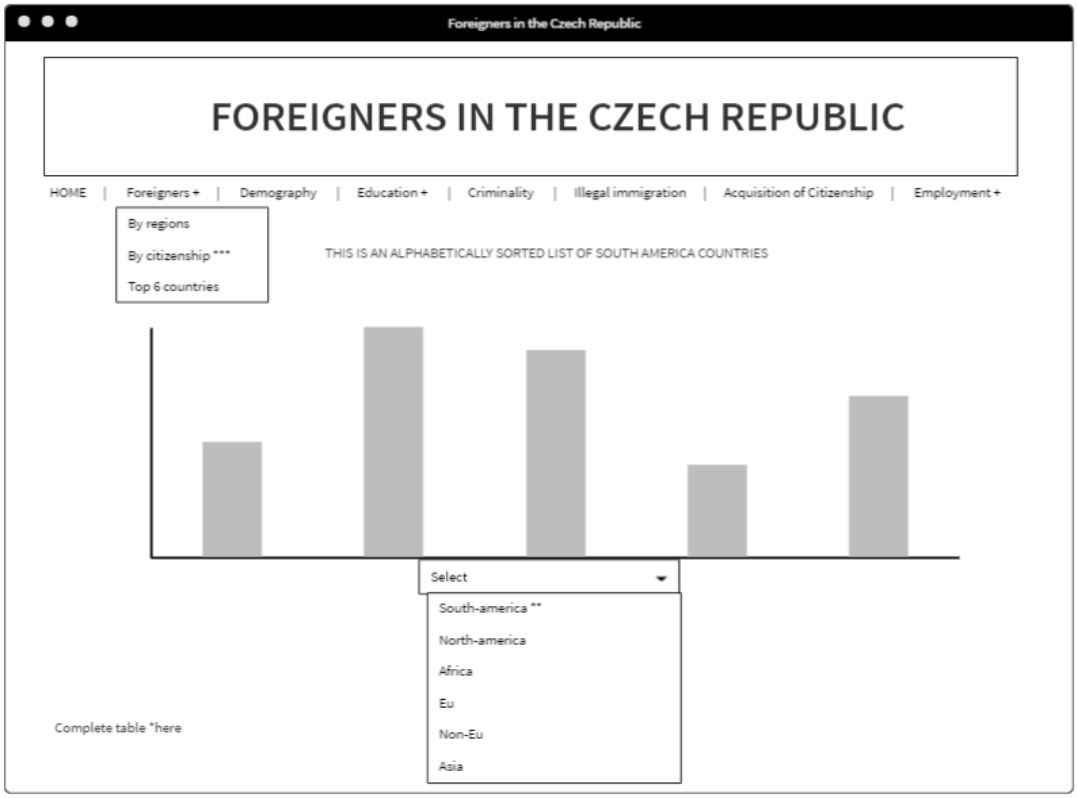
Figure 12 Foreigners by regions, Table and Mobile design



Source: own

Next wireframe design represents the sub-menu "By citizenship" of the foreigners menu. The body of this page will be divided in just one part.

Figure 13 Foreigners by citizenship design



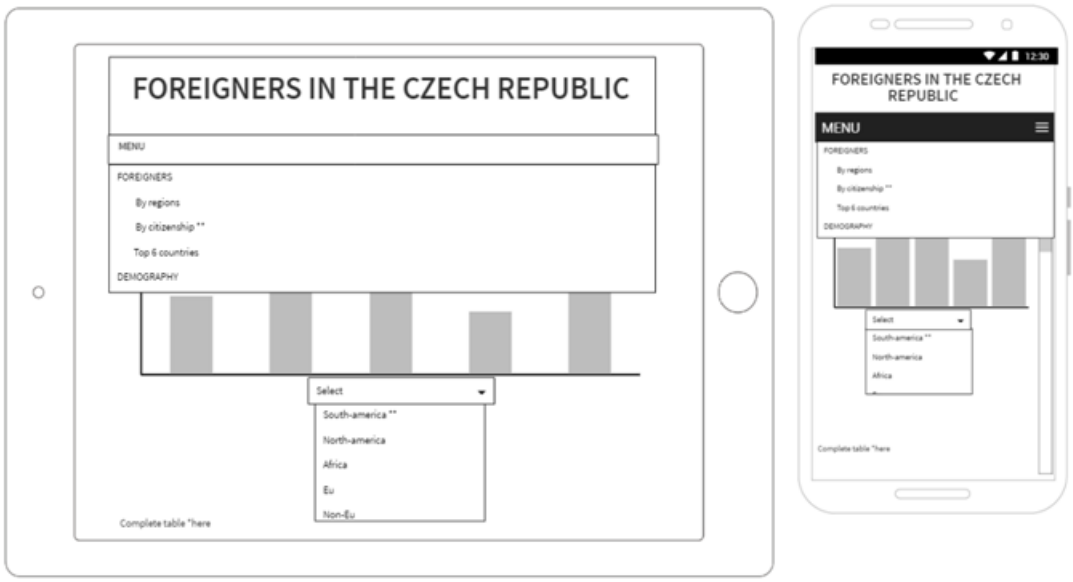
Source: own

In the body of this page will be a Bar chart which shows the total number of registered foreigners from different countries. The countries will be in an alphabetically sorted list grouped by continents as it can be seen on the drop down *"Selection option"*. According to the number of countries in each continent each Bar chart will hold maximum 15 countries in order to make the statistics more understandable on smaller devices.

At the bottom of the page the user has an option of a table view sorted by size from the year 2015 of all countries.

The following figures are a Tablet and Mobile phone wireframes of the page “By citizenship”.

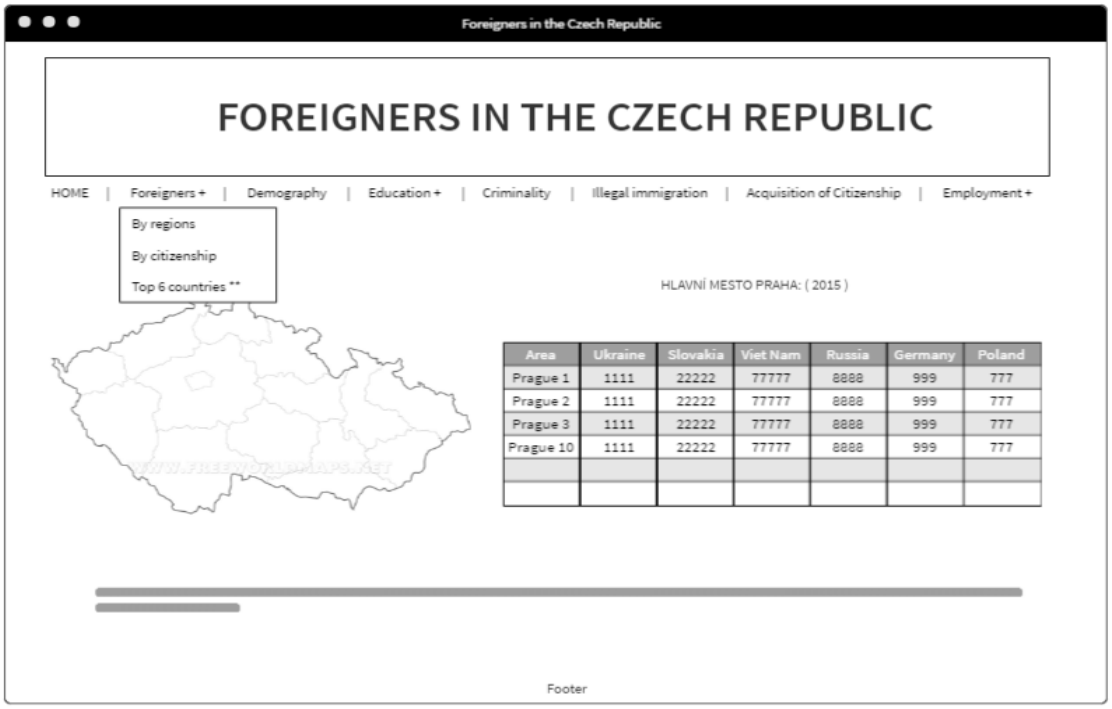
Figure 14 Foreigners by citizenship, Tablet and Mobile design



Source: own

Next wireframe design represents the sub-menu "Top 6 countries" of the foreigners menu. The body of this page will be divided in two parts.

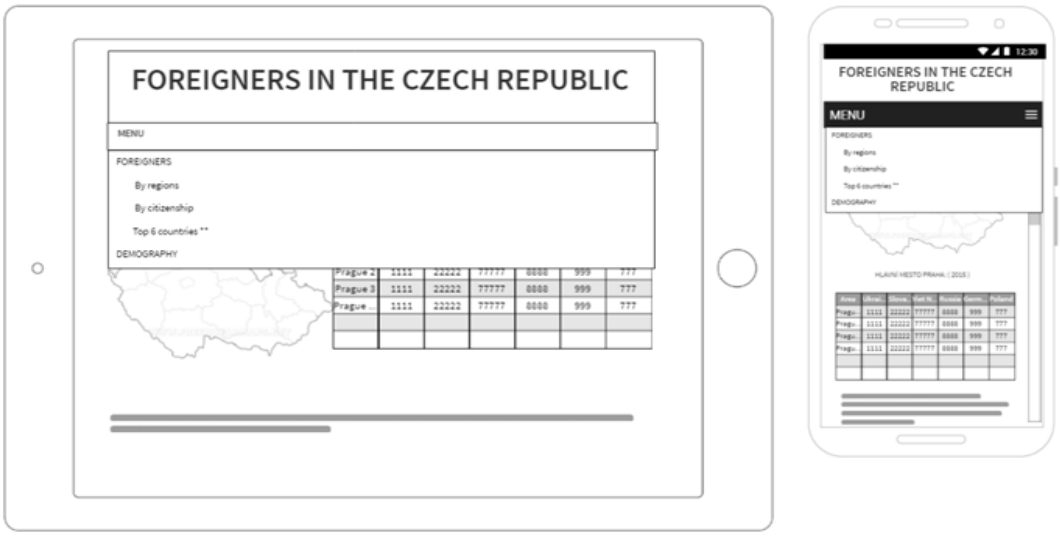
Figure 15 Foreigners top 6 countries design



Source: own

First column will be an interactive map of the Czech Republic, allowing the user to click on the map will show data on the table on the *Second column.* This table will contain the total number of foreigners in each area of the chosen region from the "Top 6 Countries" residing in the Czech Republic. The following figures are Tablet and Mobile phone wireframes of the previous page.

Figure 16 Foreigners top 6 countries, Tablet and Mobile design



Source: own

4.5 Implementation

In this part, there will be explained in detail how the application was implemented which is already running on the university server www.app.csita.cz/Statistics. For this purpose, the programming languages HTML5, CSS3, JavaScript were used and also the following libraries were used:

- CSS framework called Bootstrap was used for all the pages to make the development process faster and simpler. Example: "col s4" & "col 8" equal 12 columns as it can be seen in the figure 18. Because a responsive grid-view is divided into 12 columns, and has a total width of 100%, and will shrink and expand as user resize the browser window

Figure 17 Main layout of the HTML code

```
<!DOCTYPE html>
 <html>
   <head>
   <!-- css styles, scripts and viewport-->
   </head>
   <body>
       <div class="container">
                <!-- Page Layout here -->
           <div class="row">
               <div class="col s4">
                   <p class="parragraph">First Column.<p>
               </div>
               <div class="col s8 center">
                   <p class="parragraph">Second Column.<p>
               </div>
           </div>
           <footer class="page-footer">
               ©2016 Nivardo Villanueva Duran
           </footer>
       </div>
   </body>
 </html>
```

- *Highcharts* to create interactive Bar and Line charts.
- *CEZET Map* to create interactive map of the Czech Republic.

For the purpose of this thesis seven areas were chosen for the foreigner's statistics provided by CZSO as it is shown in the view bar in the following figure 20.

Figure 18 Bar menu of the website

4.5.1 Foreigners by type of residence

This is the main and the first page of this application showing an interactive bar chart with total number of registered foreigners by type of residence in the Czech Republic in years 1993 -2015.

It should be mentioned that all data sets for all seven areas were downloaded from the Czech Statistical Office (CZSO) in an Excel format. The following figure is shown data set for the home page.

Figure 19 Home page data set

	A	B	C	D
1	**R03 Trvale a dlouhodobě usazeni cizinci v ČR; 1985 - 2015 (31. 12.)**			
2	*Foreigners by type of residence; 1985 - 2015 (31. 12.)*			
3				
4	Pramen: Český statistický úřad, Ředitelství služby cizinecké policie			Source: Directorat
5		Typ pobytu / *Type of residence*		
6	Rok *Year*	celkem *Total*	trvalý pobyt *Permanent stay*	dlouhodobé pobyty nad 90 dnů* *Long term stay over 90 days**
7	1985	37,177	27,892	8,891
8	1986	34,803	27,278	7,146
9	1987	34,933	27,310	7,263
10	1988	35,298	27,320	7,615
11	1989	35,561	27,325	7,899
12	1990	35,198	27,204	7,695
13	1991	38,002	28,457	9,204
14	1992	49,957	29,145	20,428
15	1993	77,668	31,072	46,070
16	1994	104,343	33,164	71,179
17	1995	159,207	39,242	119,965
18	1996	199,152	46,388	152,764
19	1997	210,311	56,797	153,514
20	1998	220,187	64,352	155,835
21	1999	228,862	66,754	162,108
22	2000	200,951	66,855	134,096
23	2001	210,794	69,816	140,978
24	2002	231,608	75,249	156,359
25	2003	240,421	80,844	159,577
26	2004	254,294	99,467	154,827
27	2005	278,312	110,598	167,714
28	2006	321,456	139,185	182,271
29	2007	392,315	157,512	234,803
30	2008	437,565	172,191	265,374
31	2009	432,503	180,359	252,144
32	2010	424,291	188,952	235,339
33	2011	434,153	196,408	237,745
34	2012	435,946	212,455	223,491
35	2013	439,189	236,557	202,632
36	2014	449,367	249,856	199,511
37	2015	464,670	260,040	204,630

Source: Directorate of Alien Police Service MI CR

After downloading the file, data was collected only since 1993, because the Dissolution of Czechoslovakia took effect on 1 January 1993. These collected data about Permanent and Long-term residence (columns B and C) were put into Highcharts JS function in order to generate the bar charts as it is shown in the following figure 22.

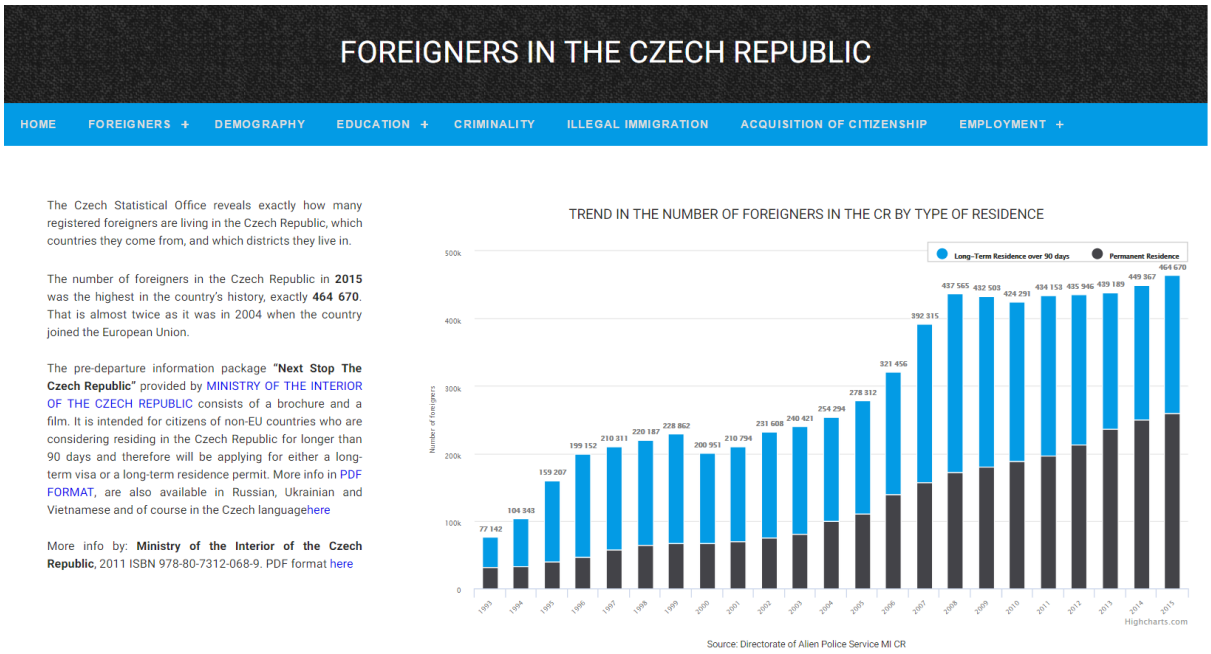
Figure 20 Highchart function used on the home page

```
xAxis: {
    categories: ['1993', '1994', '1995', '1996', '1997', '1998', '1999', '2000', '2001', '2002', '2003',
    '2004', '2005', '2006', '2007', '2008', '2009', '2010', '2011', '2012', '2013', '2014', '2015']
},
 series: [{
    name: 'Long-Term Residence over 90 days ',
    data: [46070,71179,119965,152764,153514,155835,162108,134096,140978,156359,159577,154827,
          167714,182271,234803,265374,252144,235339,237745,223491,202632,199511,204630]
 }, {
    name: 'Permanent Residence',
    data: [31072,33164,39242,46388,56797,64352,66754,66855,69816,75249,80844,99467,110598,
           139185,157512,172191,180359,188952,196408,212455,236557,249856,260040]
 }]
```

Note: Complete JS function was added in the Appendix part JS code 1.

The following figure shows the final appearance of the home page. On the left side, there is a brief interpretation about the bar chart and some extra information for foreigners provided by the Ministry of the Interior of the Czech Republic.

Figure 21 Final design of the home page

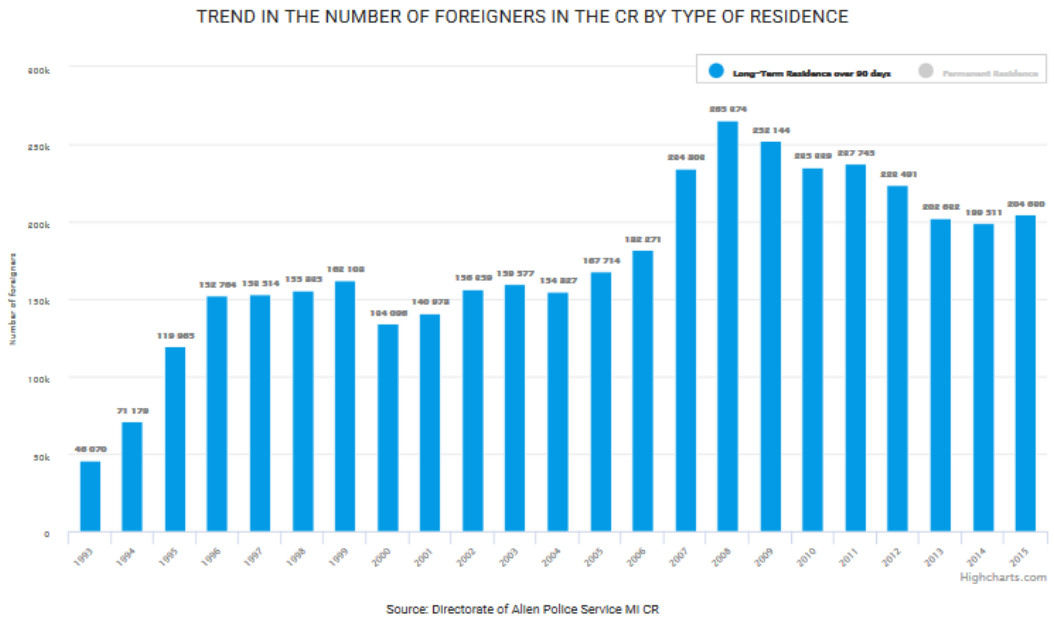


Source: own

As it can be seen the number of foreigners in the Czech Republic in 2015 was the highest in the country's history, exactly 464 670. That is almost twice as it was in 2004 when the country joined the European Union.

As it was mentioned above, Highcharts allows users to interact with the charts. In order to interact with the bar charts it is enough to turn off by clicking on the name of the type of residence. The following figure shows only the total number of foreigners with long-permit residence, and it can be seen how it was growing and decreasing in years 1993 – 2015.

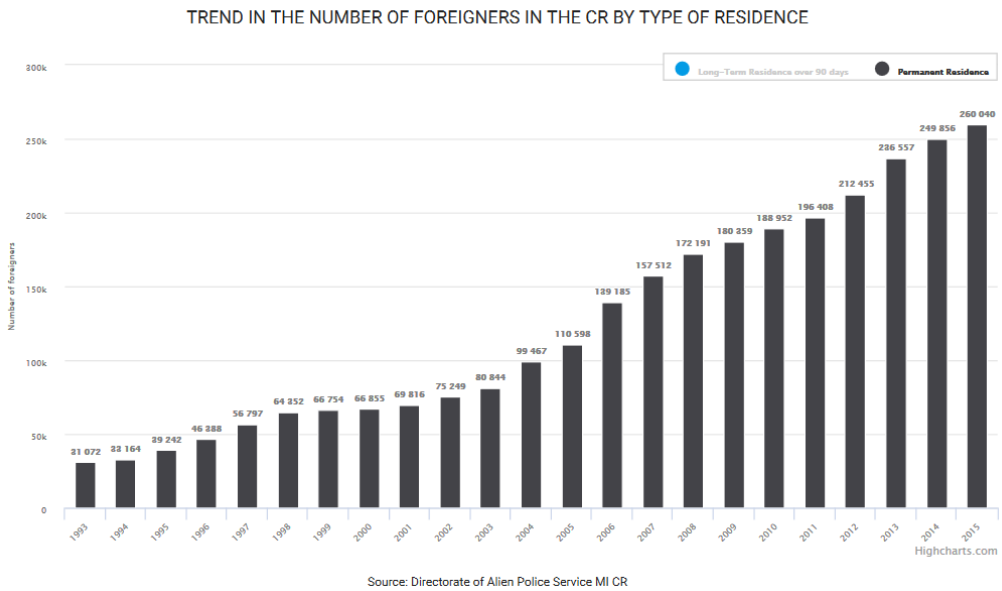
Figure 22 Totals of foreigners with Long-term residence in years 1993 - 2015



Source: Directorate of Alien Police Service MI CR

Unlike the previous chart, the following chart shows a more precise/more accurate total number of foreigners with a permanent residence which has been growing continuously in the years 1993 - 2015. In 2015, there were 3.2 times more foreigners than in 1993.

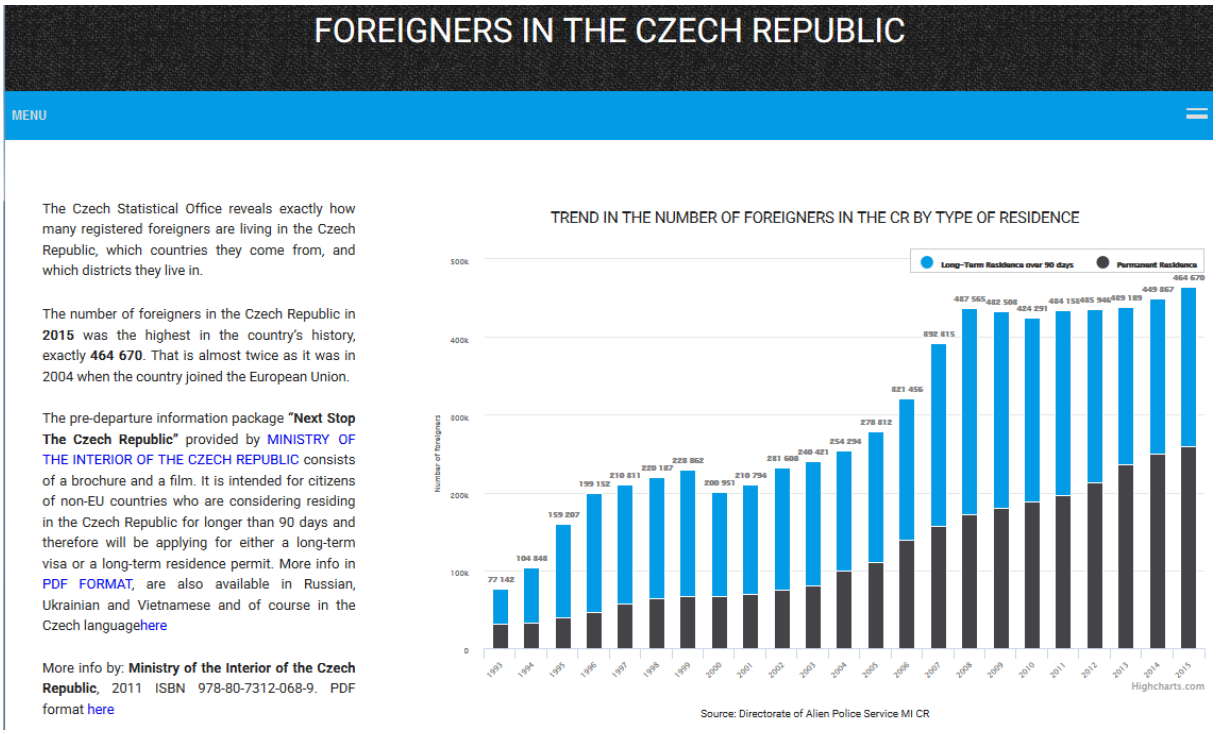
Figure 23 Totals of foreigners with Permanent residence in years 1993 - 2015



Source: Directorate of Alien Police Service MI CR

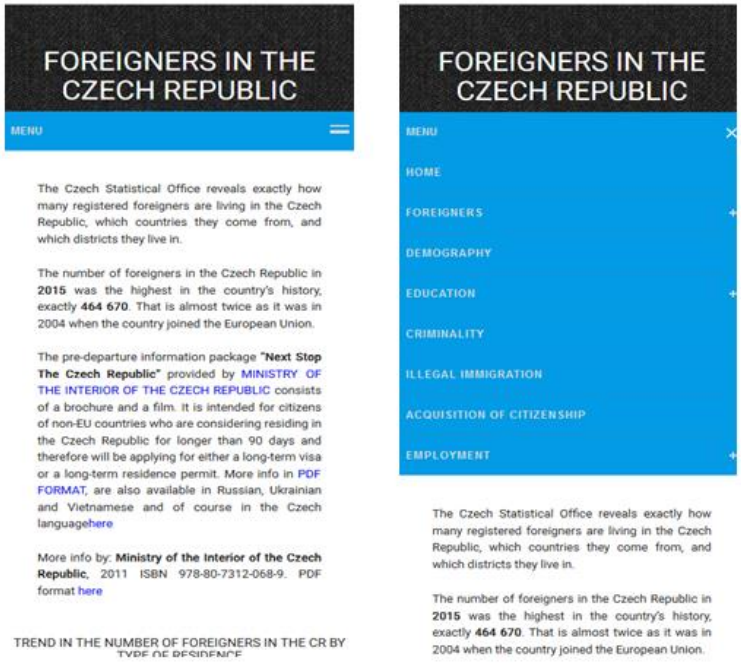
The following figures show how it looks like the home page in a Tablet and Mobile phone using a drop down menu. (To create a responsive navigation bars was used JS. Complete JS function was added in the Appendix JS code 4).

Figure 24 Final design of the home page on a tablet device



Source: own

Figure 25 Final design of the home page on a Mobile device



Source: own

Foreigners

In order to provide more understandable and accurate statistics about the total number of foreigners residing in the Czech Republic, this page has been divided into three sub-pages which are:

4.5.2 Foreigners by regions

In order to develop this page, data set was downloaded from the CZSO pages in an Excel format which contains 115 rows and 16 columns as it can be seen in the following figure 28.

Figure 26 Foreigners by regions data set

	A	B	C	D	E	F	G	H	I	O	P	Q
1	R05 Cizinci v ČR podle oblasti, kraje a okresu v letech 1996, 2002 - 2015 (stav k 31.12.)											
2	*Foreigners in the CR by area, region and district in 1996, 2002–2015 as at 31 December*											
3	Pramen: Ředitelství služby cizinecké policie											*Source: Directorate of Alien Po*
4	Oblast, kraj, okres *Area, region, district*	1996	2002	2003	2004	2005	2006	2007		2013	2014	2015
5	**ČESKÁ REPUBLIKA** *CZECH REPUBLIC*	**199,151**	**231,608**	**240,421**	**254,294**	**278,312**	**321,456**	**392,315**		**439,189**	**449,367**	**464,670**
6	**PRAHA (NUTS2)**	**61,203**	**70,978**	**69,115**	**77,922**	**89,997**	**103,482**	**129,002**		**161,006**	**166,332**	**171,408**
7	Praha 1	-	-	-	-	-	-	-	-	5,013	5,165	5,263
9	Praha 3	-	-	-	-	-	-	-	-	11,414	12,004	12,570
12	Praha 6	-	-	-	-	-	-	-	-	17,113	17,355	17,780
13	Praha 7	-	-	-	-	-	-	-	-	6,539	6,770	6,967
15	Praha 9	-	-	-	-	-	-	-	-	22,733	23,744	24,303
16	Praha 10	-	-	-	-	-	-	-	-	20,247	20,508	20,934
18	**Hlavní město Praha (NI**	**61,203**	**70,978**	**69,115**	**77,922**	**89,997**	**103,482**	**129,002**		**161,006**	**166,332**	**171,408**
107	**MORAVSKOSLEZSKO (I**	**22,779**	**19,166**	**19,959**	**18,329**	**19,337**	**20,602**	**22,962**		**23,702**	**23,924**	**24,493**
108	**Moravskoslezský kraj**	**22,779**	**19,166**	**19,959**	**18,329**	**19,337**	**20,602**	**22,962**		**23,702**	**23,924**	**24,493**
109	Bruntál	710	688	730	682	678	702	773		885	933	935
110	Frýdek-Místek	3,722	2,916	2,974	2,330	2,275	2,565	2,699		3,384	3,505	3,602
111	Karviná	8,067	6,297	6,460	6,082	6,800	7,012	7,452		6,117	6,173	6,253
112	Nový Jičín	1,233	1,430	1,479	1,207	1,271	1,359	1,460		1,749	1,743	1,800
113	Opava	884	941	917	944	974	1,052	1,197		1,567	1,612	1,649
114	Ostrava-město	8,163	6,894	7,399	7,084	7,339	7,912	9,381		10,000	9,958	10,254
115	Nezjištěno / *Not identifie*	-	-	-	312	102	119	791	-	836	693	753
	Pozn.: údaje nezahrnují cizince s platným azylem											

Source: Directorate of Alien Police Service

In order to develop an interactive page Highcharts and CEZET Map was used.

Highcharts JS function in order to generate the Bar and Line charts. The following pieces of code which is a small part of the function were used 14 times with different data according to the region to generate a Line and Bar chart.

Figure 27 Highcharts function used to generate the Line chart

```
new Chartist.Line('#chart-jihocesky', {
    labels: ['2002', '2003', '2004', '2005', '2006', '2007', '2008', '2009', '2010', '2011', '2012', '2013', '2014', '2015'],
    series: [[8698,9660,9954,10595,12584,15171,16560,15415,15037,14894,14838,15200,15366,16390]]
}, {
    low: 0,
    plugins: [
        Chartist.plugins.ctPointLabels({
            textAnchor: 'middle'
        })
    ]
});
```

Source: own

In the above figure the entered data generates a Line chart with the total foreigners in the South Bohemian region (Jihočeský) in years 2002 - 2015.

Figure 28 Highcharts function used to generate the Bar chart

```
series: [{
    name: 'České Budějovice ',
  data: [2954,3243,2826,3075,3932,4716,4935,4737,4726,4855,4970,5121,5130,5391]
}, {
    name: 'Český Krumlov ',
    data: [1618,1717,1929,2123,2364,2737,2844,2791,2867,2734,2606,2660,2638,2706]
}, {
    name: 'Jindřichův Hradec ',
    data: [919,1084,1212,1261,1278,1431,2052,1777,1667,1667,1621,1638,1650,1729]
}, {
    name: 'Písek ',
    data: [590,631,689,754,903,1056,1137,1048,1065,1099,1163,1286,1419,1728]
},{
    name: 'Prachatice ',
    data: [750,830,964,961,997,1159,1248,1213,1171,1093,1079,1112,1081,1203]
},{
    name: 'Strakonice ',
    data: [1215,1450,1608,1543,2085,2870,3010,2413,2027,1860,1767,1742,1773,1870]
},{
    name: 'Tábor ',
    data: [652,705,726,878,1025,1202,1334,1436,1514,1586,1632,1641,1675,1763]
}]
```

Source: own

Note: Complete JavaScript function for generating Bar and Line charts for the South Bohemian region were added in the Appendix part JS code 2 and 3.

In order to generate a Bar chart of each region, data was separated into areas. As it can be seen in the previous figure the South Bohemian region (Jihočesky) is divided in seven areas.

***CEZET Map** was used* to create an interactive map of the Czech Republic. By clicking on the map users can interact and obtain the following results such as:

- **Table** shows the total number of foreigners in each area of the chosen region in 2015. All data about each region was introduced manually to the html code as it can be seen in the following figure which represent data of South Bohemian region (Jihočesky).

Figure 29 HTML code to generate the table of "South Bohemian region"

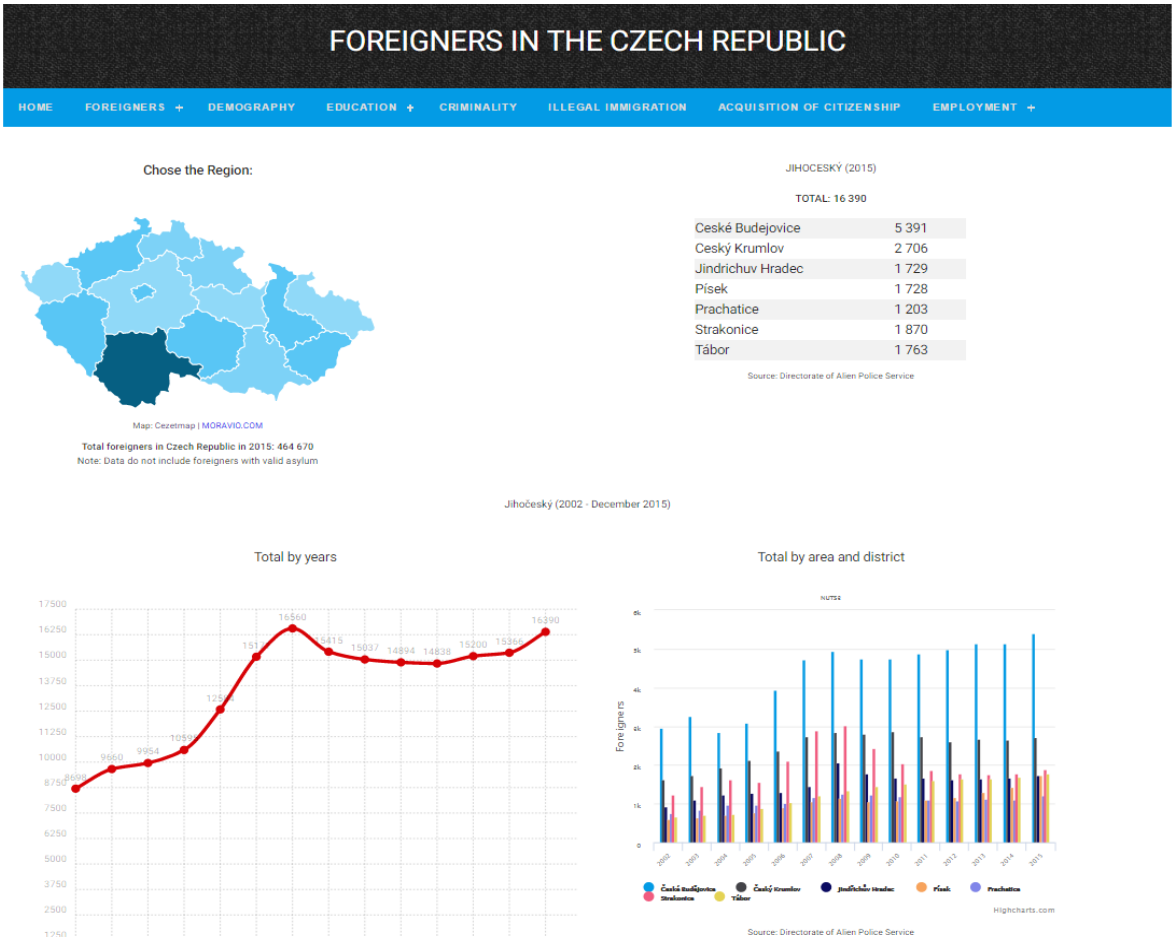
```
<div class="kraj-tabulka kr-jihocesky display-none">
    <h3>Jihoceský (2015)</h3>
    <h3><strong>Total: 16 390</strong></h3>
    <table class="table striped">
        <tr><td>Ceské Budejovice</td><td>5 391</td></tr>
        <tr><td>Ceský Krumlov</td><td>2 706</td></tr>
        <tr><td>Jindrichuv Hradec</td><td>1 729</td></tr>
        <tr><td>Písek</td><td>1 728</td></tr>
        <tr><td>Prachatice</td><td>1 203</td></tr>
        <tr><td>Strakonice</td><td>1 870</td></tr>
        <tr><td>Tábor</td><td>1 763</td></tr>

    </table>
    <p class="source-title">Source: Directorate of Alien Police Service</p>
</div>
```

Source: own

- **Line chart** shows the total number of foreigners in the chosen region in between years 2002 - 2015.
- **Bar chart** shows the total number of foreigners in each area of the chosen region in years 2002 -2015, it means if in the region there are 8 areas; each of the years will have 8 bar charts. By clicking on the name of the area an user can interact with the chart. For example the figure 33 shows only the total number of foreigners living in *České Budějovice* and *Český Krumlov* which are the main cities of the South bohemian region.

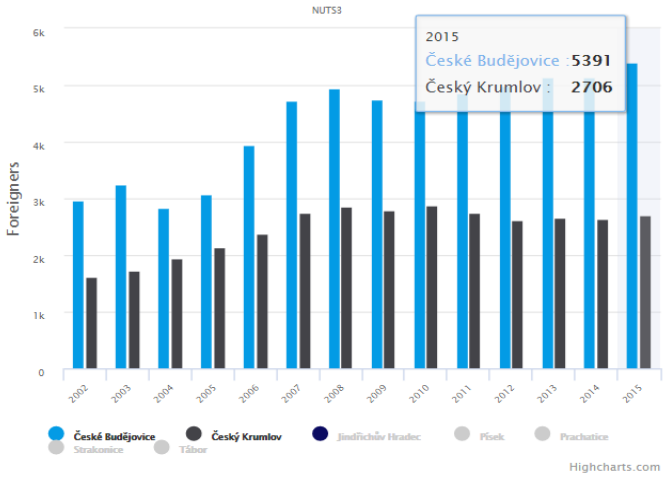
Figure 30 Final design of the page By regions



Source: own

As it can be seen in the above figure 32, the Excel data set is represented in a more comprehensive way, so everyone can easily understand it.

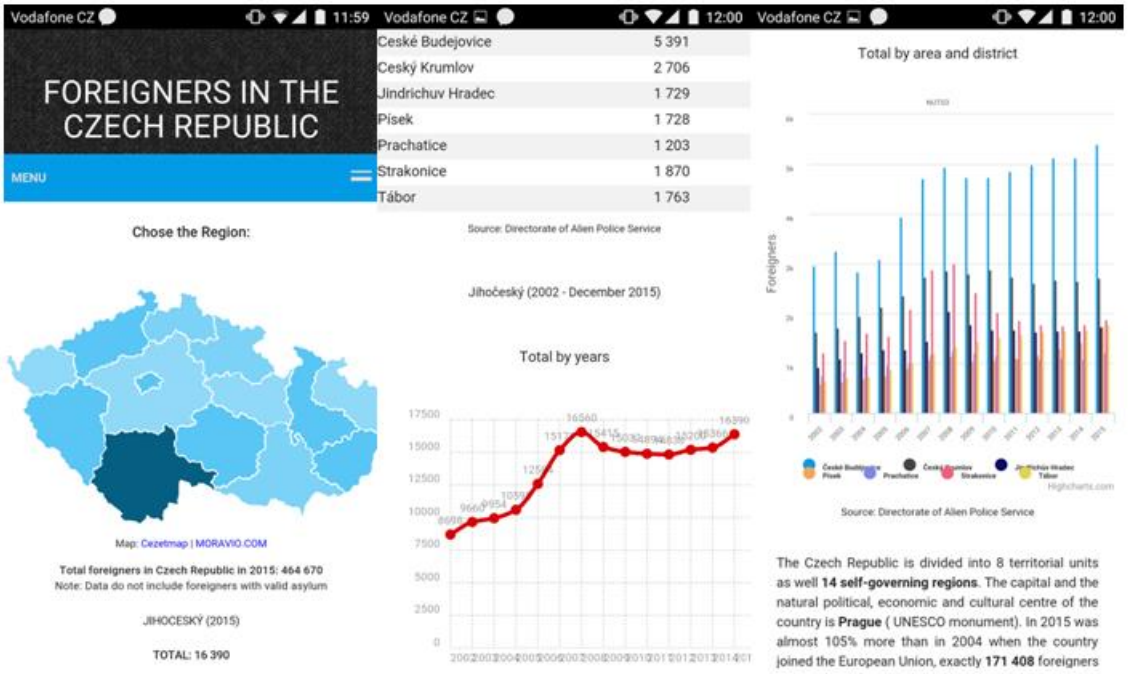
Figure 31 Total number of foreigners in *České Budějovice* and *Český Krumlov*



Source: Directorate of Alien Police Service

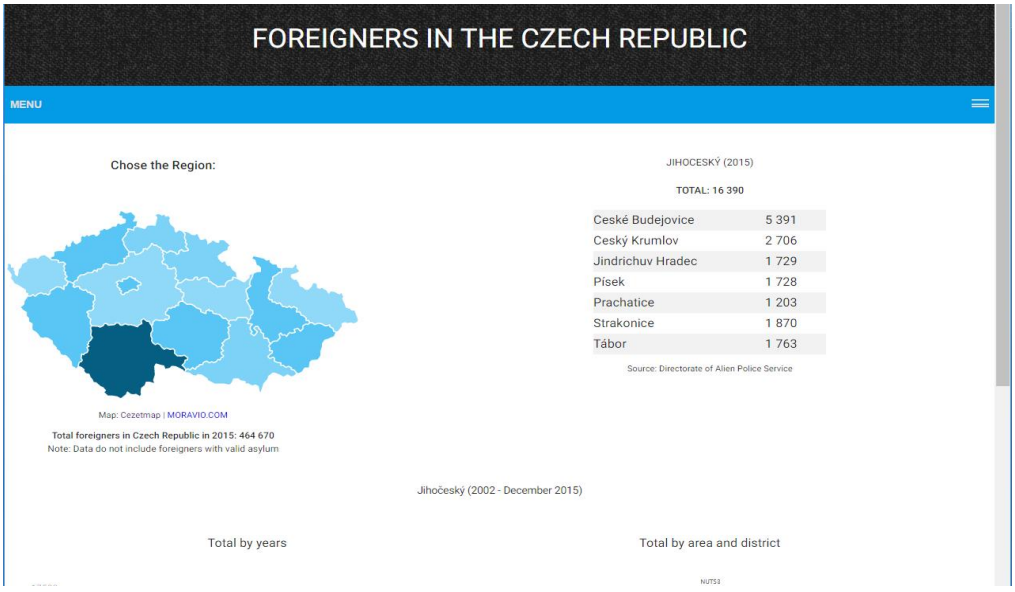
In order to see the complete information of the page on the mobile and tablet it is necessary to slide down as it can be seen in the following figures.

Figure 32 Final design of the page By regions on a Mobile device



Source: own

Figure 33 Final design of the page By regions on a Tablet device



Source: own

4.5.3 Foreigners by citizenship

In order to develop this page, data set was downloaded from the CZSO website in an Excel format which contains 197 rows and 112 columns as it can be seen in the figure 36. For the purpose of this page it was only collected data from the last ten years 2005 - 2015

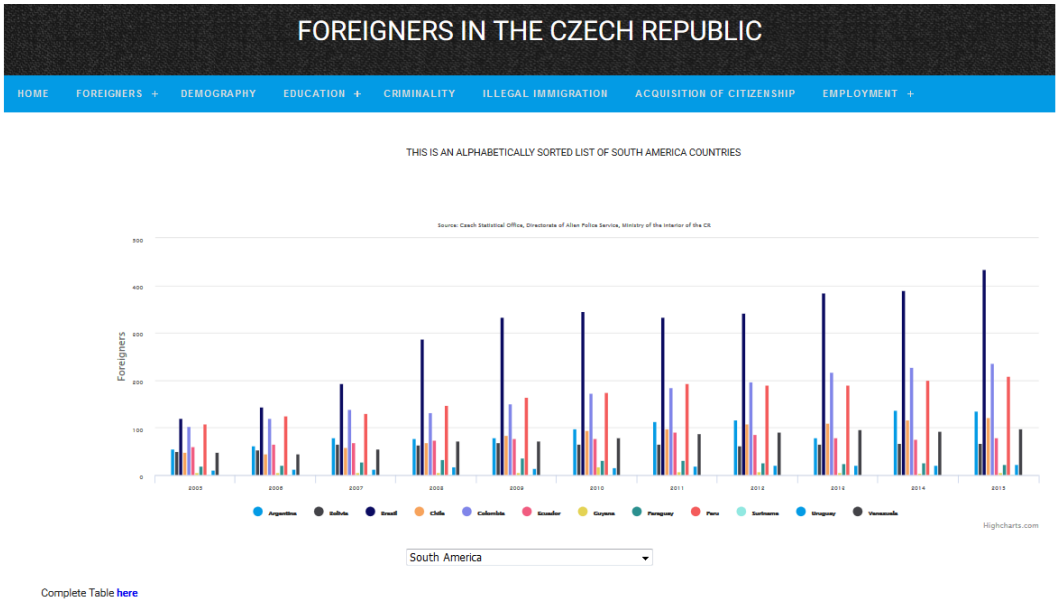
Figure 34 Foreigners by citizenship data set

	A	B	D	F	H	J	L	N	P	R	S	AQ	AS
1		1994	1995	1996	1997	1998	1999	2000	2001	2002		2014	2015
2	Citizenship	celkem	celkem	celkem	celkem	celkem	celkem	celkem	celkem	celkem		celkem	celkem
3		Total	Total	Total	Total	Total	Total	Total	Total	Total		Total	Total
4	**Foreigners in the CR, total**	**104,343**	**159,207**	**199,152**	**210,311**	**220,187**	**228,862**	**200,951**	**210,794**	**231,608**		**449,367**	**464,670**
5	Afghanistan	184	208	172	173	154	141	117	87	98		216	257
6	Albania	57	60	72	90	134	125	121	141	150		272	295
7	Algeria	165	246	406	524	666	568	416	381	381		684	701
8	Samoa	-	-	-	-	-	1	-	-	-		-	-
9	Andorra	-	1	1	1	-	-	-	-	-		-	-
10	Angola	301	354	300	282	243	211	170	158	153		143	142
11	Argentina	32	35	42	27	32	36	35	38	43		136	134
12	Armenia	438	866	1,004	1,158	1,115	1,173	1,081	1,046	1,005		1,719	1,672
13	Australia	218	267	334	261	287	266	239	243	266		588	592
14	Azerbaijan	28	45	33	40	43	62	71	86	133		812	840
15	Bahamas	1	1	1	-	-	-	-	-	-		-	-
16	Bahrain	25	14	20	48	64	68	57	49	48		9	11
17	Bangladesh	38	40	53	53	59	45	36	31	35		143	150
18	Barbados	-	-	-	-	-	-	-	-	-		1	1
19	Belgium	215	271	296	272	290	333	275	296	329		630	665
20	Belize	-	-	2	2	3	4	3	3	3		2	2
21	Belarus	154	400	1,129	3,417	3,844	3,943	2,633	2,536	2,728		4,401	4,491
22	Benin	49	43	49	49	54	45	49	44	43		44	41
23	Bhutan	-	-	-	-	-	-	-	-	-		3	5
145	Romania	1,368	1,628	2,029	2,382	2,694	2,577	2,390	2,304	2,302		7,741	9,116
175	Sri Lanka	27	32	23	21	29	26	20	21	28		98	100
192	Vanuatu	-	-	-	-	-	-	-	-	-		1	1
193	United Kingdom	1,365	1,940	1,490	1,721	1,648	1,720	1,490	1,628	1,824		5,647	5,966
194	Venezuela, Bolivarian Republic	22	20	36	43	38	36	37	37	37		92	98
195	Viet Nam	9,633	14,213	17,620	20,950	22,875	24,824	23,556	23,924	27,143		56,609	56,900
196	Wallis a Futuna	-	-	-	-	-	-	-	-	-		-	-
197	Zambia	29	24	22	26	19	20	17	18	19		43	46
198	Zimbabwe	13	12	15	19	15	13	13	12	14		31	36
199	Stateless + Other + Not identified	666	621	550	544	448	474	462	436	422		983	849

Source: Czech Statistical Office, Directorate of Alien Police Service, Ministry of the Interior of the CR

In order to develop and represent all this complex data, Bar chart was used in the same way as on the previous pages (figure 30). The collected data was put into a Highcharts JS function to generate the chart, which makes it more understandable in the eyes of any user without needing to have any knowledge in statistics which can be seen in the following figure 37.

Figure 35 Final design of the page By citizenship



Source: own

Using the highchart as it was explained in the previous pages, makes the bar chart more useful. For example if anyone for any reason would like to know if in the Czech Republic are more Bolivians or Peruvians. Users can compare these two countries more easily. As it can be seen in the following figure 38.

Figure 36 Total of foreigners from Bolivia and Peru in years 2005 - 2015

Source: Czech Statistical Office, Directorate of Alien Police Service, Ministry of the Interior of the CR

In order to see the statistics about the total number of foreigner from all the world there are two options:

- **Table view**, this option is at the bottom of the page which links to a new page which contains a table with almost 197 countries sorted by the larger number of foreigners from the last year (2015) as it can be seen in figure 38.

In order to create the table, all collected data was converted to csv format Figure 39. Then JavaScript was used to generate the table as it can be seen in the figure 40.

Figure 37 Data set for the complete table of citizenship

bycitizenshipdecade.csv

```
Ukraine;87 789;102 594;126 721;131 921;131 932;124 281;118 932;112 549;105 138;104
Slovakia;49 446;58 384;67 889;76 034;73 446;71 780;81 253;85 807;90 948;96 222;101
Viet Nam;36 833;40 779;51 101;60 255;61 115;60 289;58 205;57 300;57 347;56 609;56
Russian Federation;16 273;18 564;23 278;27 086;30 297;31 807;32 377;32 961;33 138;
Germany;7 187;10 109;15 700;17 496;13 792;13 871;15 763;17 149;18 507;19 687;20 46
Poland;17 810;18 894;20 601;21 710;19 273;18 242;19 058;19 235;19 452;19 626;19 84
Bulgaria;4 551;4 635;5 021;5 922;6 403;6 927;7 435;8 222;9 132;10 058;10 984
Romania;2 701;2 816;3 177;3 615;4 091;4 410;4 842;5 664;6 777;7 741;9 116
United States;3 952;4 212;4 452;5 272;5 941;6 074;7 317;6 976;7 134;6 476;6 478
Mongolia;2 435;3 280;6 026;8 569;5 745;5 576;5 385;5 306;5 287;5 461;5 986
United Kingdom;2 235;2 871;3 775;4 512;4 363;4 356;4 924;5 210;5 376;5 647;5 966
China;3 580;4 157;4 978;5 203;5 352;5 470;5 579;5 600;5 503;5 574;5 721
Kazakhstan;2 247;2 379;2 959;3 363;3 905;4 243;4 534;4 753;4 821;5 000;5 141
.
.
.
```

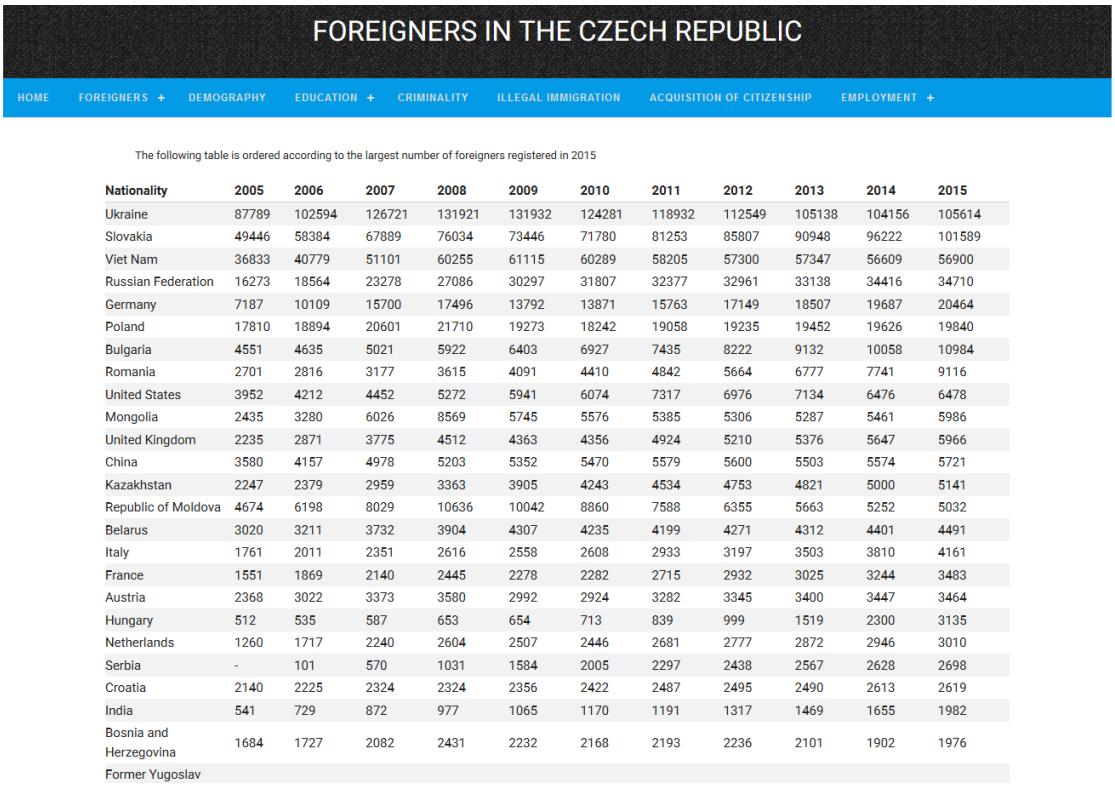
Source: own

Figure 38 JS function to generate complete table of citizenship

```
$(document).ready(function() {
    var fileContent = readTextFile('./data/bycitizenshipdecade.csv');
    var data = $.csv.toArrays(fileContent, {
        separator: ";"
    });
    for (var i = 0; i < data.length; i++) {
        var state = data[i][0];
        var data2005 = data[i][1].replace(/ /g,"");
        var data2006 = data[i][2].replace(/ /g,"");
        var data2007 = data[i][3].replace(/ /g,"");
        var data2008 = data[i][4].replace(/ /g,"");
        var data2009 = data[i][5].replace(/ /g,"");
        var data2010 = data[i][6].replace(/ /g,"");
        var data2011 = data[i][7].replace(/ /g,"");
        var data2012 = data[i][8].replace(/ /g,"");
        var data2013 = data[i][9].replace(/ /g,"");
        var data2014 = data[i][10].replace(/ /g,"");
        var data2015 = data[i][11].replace(/ /g,"");
        var
        append = '<tr>';;
        append += '<td>' + state + '</td>';
        append += '<td>' + data2005 + '</td>';
        append += '<td>' + data2006 + '</td>';
        append += '<td>' + data2007 + '</td>';
        append += '<td>' + data2008 + '</td>';
        append += '<td>' + data2009 + '</td>';
        append += '<td>' + data2010 + '</td>';
        append += '<td>' + data2011 + '</td>';
        append += '<td>' + data2012 + '</td>';
        append += '<td>' + data2013 + '</td>';
        append += '<td>' + data2014 + '</td>';
        append += '<td>' + data2015 + '</td>';
        append += '</tr>';
        $('.append-csv').append(append);
    }
});
```

Source: own

Figure 39 Final result of the complete table of citizenship



FOREIGNERS IN THE CZECH REPUBLIC

HOME FOREIGNERS + DEMOGRAPHY EDUCATION + CRIMINALITY ILLEGAL IMMIGRATION ACQUISITION OF CITIZENSHIP EMPLOYMENT +

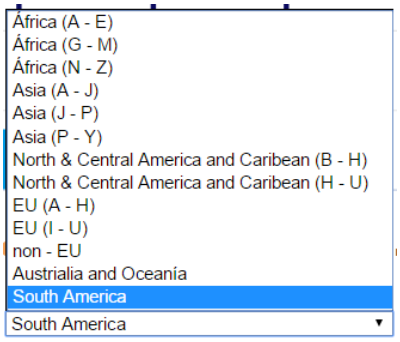
The following table is ordered according to the largest number of foreigners registered in 2015

Nationality	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Ukraine	87789	102594	126721	131921	131932	124281	118932	112549	105138	104156	105614
Slovakia	49446	58384	67889	76034	73446	71780	81253	85807	90948	96222	101589
Viet Nam	36833	40779	51101	60255	61115	60289	58205	57300	57347	56609	56900
Russian Federation	16273	18564	23278	27086	30297	31807	32377	32961	33138	34416	34710
Germany	7187	10109	15700	17496	13792	13871	15763	17149	18507	19687	20464
Poland	17810	18894	20601	21710	19273	18242	19058	19235	19452	19626	19840
Bulgaria	4551	4635	5021	5922	6403	6927	7435	8222	9132	10058	10984
Romania	2701	2816	3177	3615	4091	4410	4842	5664	6777	7741	9116
United States	3952	4212	4452	5272	5941	6074	7317	6976	7134	6476	6478
Mongolia	2435	3280	6026	8569	5745	5576	5385	5306	5287	5461	5986
United Kingdom	2235	2871	3775	4512	4363	4356	4924	5210	5376	5647	5966
China	3580	4157	4978	5203	5352	5470	5579	5600	5503	5574	5721
Kazakhstan	2247	2379	2959	3363	3905	4243	4534	4753	4821	5000	5141
Republic of Moldova	4674	6198	8029	10636	10042	8860	7588	6355	5663	5252	5032
Belarus	3020	3211	3732	3904	4307	4235	4199	4271	4312	4401	4491
Italy	1761	2011	2351	2616	2558	2608	2933	3197	3503	3810	4161
France	1551	1869	2140	2445	2278	2282	2715	2932	3025	3244	3483
Austria	2368	3022	3373	3580	2992	2924	3282	3345	3400	3447	3464
Hungary	512	535	587	653	654	713	839	999	1519	2300	3135
Netherlands	1260	1717	2240	2604	2507	2446	2681	2777	2872	2946	3010
Serbia	-	101	570	1031	1584	2005	2297	2438	2567	2628	2698
Croatia	2140	2225	2324	2324	2356	2422	2487	2495	2490	2613	2619
India	541	729	872	977	1065	1170	1191	1317	1469	1655	1982
Bosnia and Herzegovina	1684	1727	2082	2431	2232	2168	2193	2236	2101	1902	1976
Former Yugoslav											

Source: own

Using the Selection option which is at the bottom of the bar chart, users can change the chart by choosing of the following options as it can be seen in the following figure.

Figure 40 List of countries grouped by continents



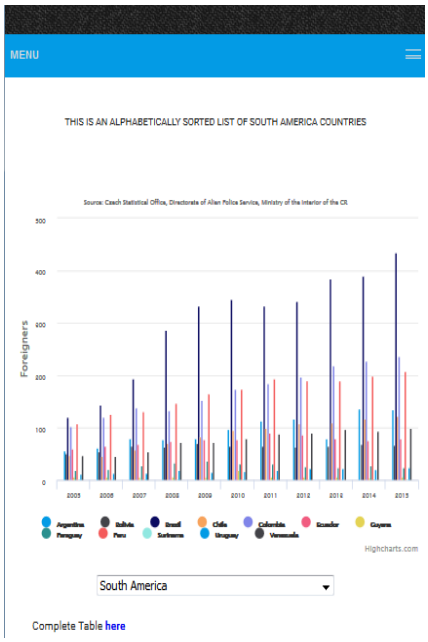
Source: own

The following figures show how it would look like on a Tablet and Mobile phone.

Figure 41 Final design of the page By citizenship on a Tablet device

Source: own

Figure 42 Final design of the page By citizenship on a Mobile device



Source: own

4.5.4 Top 6 Countries

In order to develop this page just *CEZET Map* was used to create an interactive map of the Czech Republic, by clicking on a different region it will show in the table view. This table contains the total number of foreigners in each area of the chosen region from the Top 6 Countries residing in the Czech Republic, which are Ukraine, Slovakia,

Viet Nam, Russia, Germany and Poland. The same as the previous page all data of these countries were introduced manually into the html code for each region as it can be seen in the figure 46.

The downloaded data set contains 114 columns and lot of rows but for the purpose of this page was used only 6 as it can be seen in the following figure.

Figure 43 Top 6 countries data set

	A	BP	BQ	BR	BS	BT	BU
1	Pramen: Ředitelství služby cizinecké p				Source: Directorate of Alien Police Service		
2	Oblast, kraj, okres *Area, Region, District*	31. 12. 2015					
3		Ukrajina *Ukraine*	Slovensko *Slovakia*	Vietnam *Viet Nam*	Rusko *Russian Fed.*	Německo *Germany*	Polsko *Poland*
4	**ČESKÁ REPUBLIKA** ***CZECH REPUBLIC***	**######**	**101,589**	**56,900**	**34,710**	**20,464**	**19,840**
5	**PRAHA (NUTS2)**	**45,633**	**27,563**	**11,707**	**21,338**	**3,509**	**2,967**
6	**Hlavní město Praha (NUTS3)**	**45,633**	**27,563**	**11,707**	**21,338**	**3,509**	**2,967**
7	Praha 1	477	493	276	518	228	73
8	Praha 2	1,541	1,209	398	1,263	437	167
9	Praha 3	3,189	1,938	512	1,703	294	208
10	Praha 4	8,927	5,399	5,636	2,596	459	615
11	Praha 5	7,889	4,200	959	5,112	690	570
12	Praha 6	3,278	2,315	486	2,881	484	293
13	Praha 7	1,457	1,123	521	836	192	76
14	Praha 8	4,039	2,195	510	1,469	203	201
15	Praha 9	8,892	4,574	1,023	2,503	238	340
16	Praha 10	5,933	3,921	1,379	2,453	273	412
17	Praha	11	196	7	4	11	12
18	**STŘEDNÍ ČECHY (NUTS2)**	**16,185**	**18,307**	**5,236**	**4,470**	**1,147**	**2,678**
19	**Středočeský kraj (NUTS3)**	**16,185**	**18,307**	**5,236**	**4,470**	**1,147**	**2,678**
20	Benešov	576	593	261	68	43	124
21	Beroun	924	1,154	363	207	94	50
22	Kladno	1,697	1,937	791	627	84	174
23	Kolín	818	1,187	359	109	45	138
24	Kutná Hora	570	573	333	31	27	86
25	Mělník	1,557	960	341	170	61	97
26	Mladá Boleslav	1,596	4,477	675	242	121	1,353
27	Nymburk	1,183	983	313	343	39	82
28	Praha - východ	3,679	3,229	406	957	197	217
29	Praha - západ	2,320	2,193	625	1,554	265	212
30	Příbram	768	671	293	108	80	50
31	Rakovník	497	350	476	54	91	95
32	**JIHOZÁPAD (NUTS2)**	**9,852**	**10,491**	**8,105**	**920**	**3,088**	**1,187**
33	**Jihočeský kraj (NUTS3)**	**4,005**	**3,474**	**2,758**	**504**	**797**	**342**
34	České Budějovice	1,394	1,243	622	283	269	42
35	Český Krumlov	542	393	502	78	136	70
36	Jindřichův Hradec	231	321	545	42	91	50
106	**MORAVSKOSLEZSKO (NUTS**	**1,236**	**8,089**	**4,286**	**475**	**383**	**5,369**
107	**Moravskoslezský kraj (NUTS**	**1,236**	**8,089**	**4,286**	**475**	**383**	**5,369**
108	Bruntál	50	331	155	8	27	167
109	Frýdek-Místek	134	1,379	344	51	51	844
110	Karviná	144	1,904	285	61	54	3,336
111	Nový Jičín	124	744	337	36	53	129
112	Opava	103	481	333	44	97	249
113	Ostrava-město	681	3,250	2,832	275	101	644
114	Nezjištěno / *Not identified*	158	150	39	42	19	17
116	*1)* Údaje nezahrnují cizince s platným a na území ČR.				*1) Data do not include foreigners with valid asylum status on the territory of the CR.*		

Source: Directorate of Alien Police Service

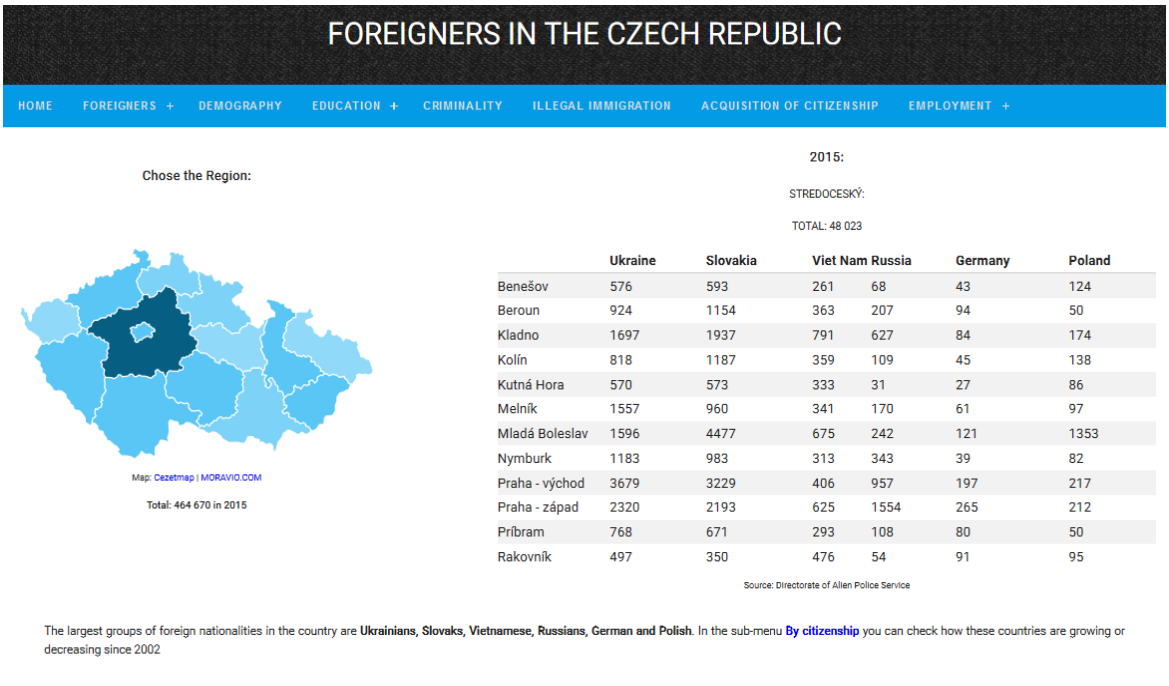
Figure 44 HTML code “Top 6 countries page - Karlovy Vary Region”

```
<div class="kraj-tabulka kr-karlovarsky">
    <strong>2015:</strong></br>
    <h3>Karlovarský:</h3>
    <h3>Total: 16204</h3>
    <table class="table striped">
        <thead>
        <tr>
            <td></td>
            <td>Ukraine</td>
            <td>Slovakia</td>
            <td>Viet Nam</td>
            <td>Russia</td>
            <td>Germany</td>
            <td>Poland</td>
        </tr>
        </thead>
        <tbody>
        <tr>
            <td>Cheb</td>
            <td>770</td>
            <td>735</td>
            <td>403</td>
            <td>700</td>
            <td>81</td>
        </tr>
        <tr>
            <td>Karlovy Vary</td>
            <td>1364</td>
            <td>709</td>
            <td>2469</td>
            <td>1811</td>
            <td>1206</td>
            <td>77</td>
        </tr>
        <tr>
            <td>Sokolov</td>
            <td>260</td>
            <td>528</td>
            <td>738</td>
            <td>132</td>
            <td>690</td>
            <td>58</td>
        </tr>
        </tbody>
    </table>
</div>
```

Source: own

Following figure shows how the finished "Top 6 Countries" page looks like.

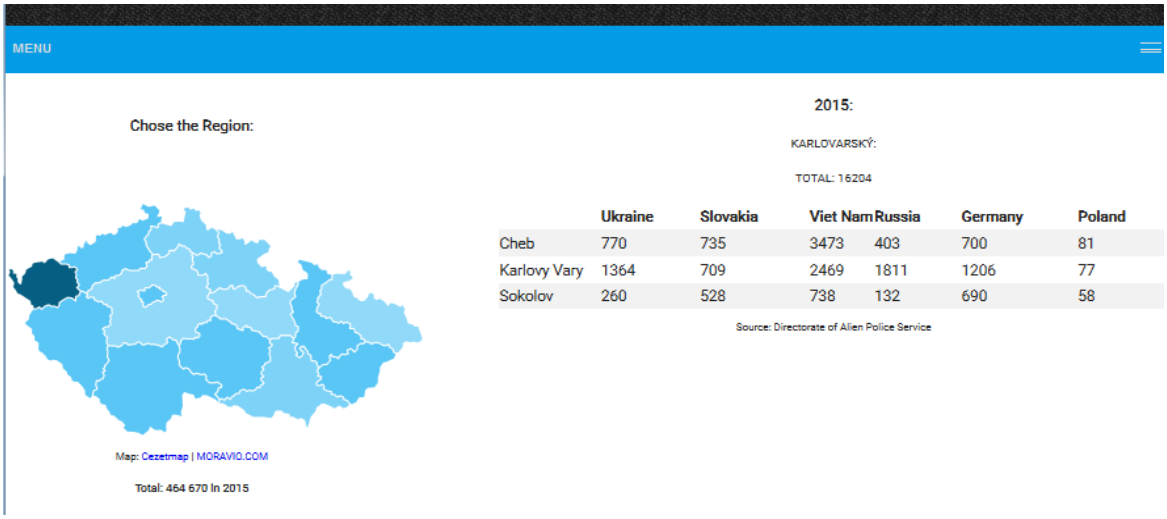
Figure 45 Final design of the page Top 6 countries



Source: own

The only difference between Table and Desktop version it is in the responsive menu bar.

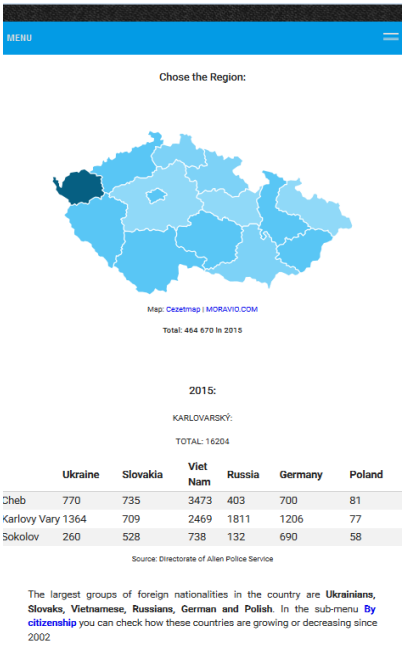
Figure 46 Final design of the page Top 6 countries on a Tablet device



Source: own

The same as in the previous pages the mobile version it is necessary to slip down in order to see the entire page, because it shows into two rows. In the first row is just the map followed by a table.

Figure 47 Final design of the page Top 6 countries on a Mobile device



Source: own

5 Results and discussion

5.1 Evaluation of the application

As it was mentioned in the introduction of the practical part CZSO provides statistics about registered foreigners residing in the Czech Republic in 8 dynamic tables which only a few of them have a chart view. But more statistics about foreigners can be found among other areas, which can make the search process longer and complex.

This application is not just focused to help foreigners. As it was mentioned in the introduction of the thesis it can also benefit the community, municipality, companies, tourists or anyone who can find it useful, helping them to easily find precise statistics and then they can make a decision and conclusions based on meaningful charts presented on this application.

5.2 Comparing with other applications

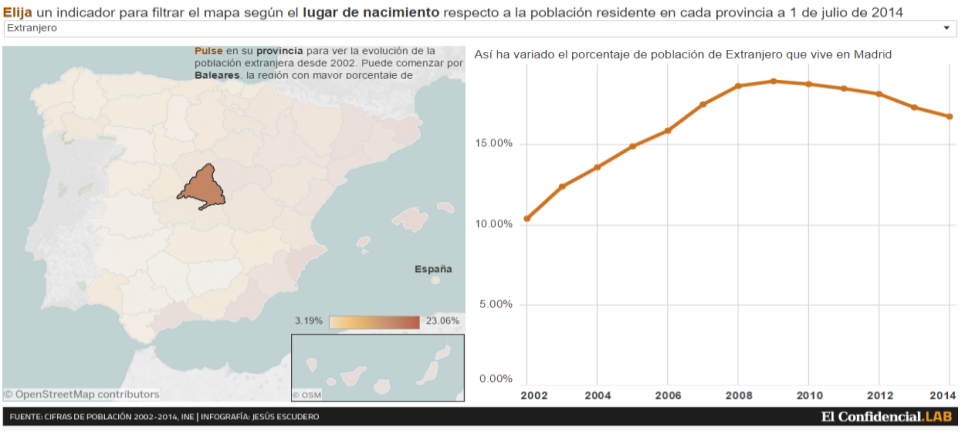
For the purpose of this thesis, the following two applications have been selected because they have almost similar features of the developed application.

5.2.1 Spanish application

Called: "*¿Cuántos extranjeros hay en su provincia?"* which means "How many foreigners are in your province?" was published by the newspaper "El confidencial" on 26.01.2015. [30]

This application allows users to interact with the map, by clicking on a specific region which will show a Line chart on the left side, which contains the total number to foreigners from 2002 to 2014. Figure 48 shows an example of Total foreigners living in Madrid.

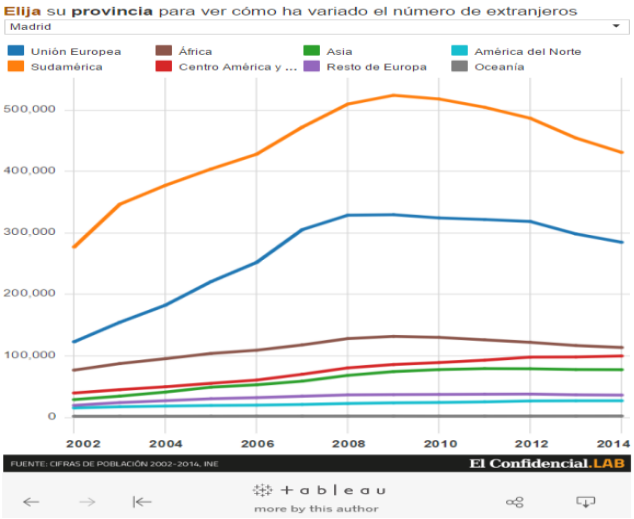
Figure 48 Main view of the Spanish application



Source: El confidencial

It also allows users to check how many foreigners are from: Union Europe, South America, Africa, Central and North America, Asia, Oceania and the rest of European countries are living in each region of Spain between the years 2002 - 2014. Figure 49 shows an example of foreigners living in Madrid.

Figure 49 Second view of the Spanish application



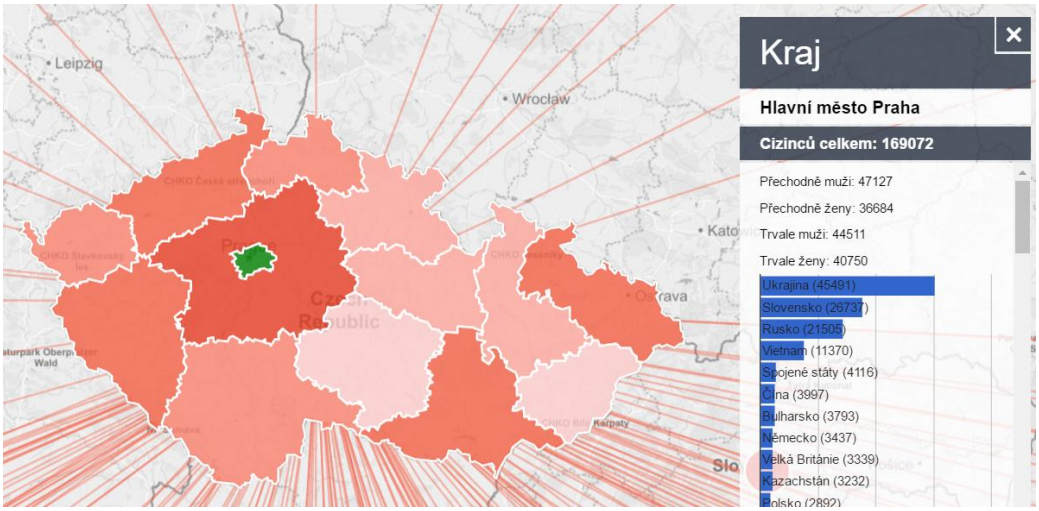
Source: El confidencial

5.2.2 Czech application

Called: "Rozmístění Cizinců v ČR" which means "Distribution of foreigners in the Czech Republic". Developed by **mfox.cz** development team. They are specializing in processing geodata and creating digital printed map outputs. They develop their own user-friendly web mapping application using the latest open source technologies.[32]

This web application allows users to interact with a map of the Czech Republic. By clicking on the region it shows the following information about foreigners: Total number, Total number by gender and type of residence and a sorted list by the largest number of foreigners from each countries as it can be seen on the drop down list.

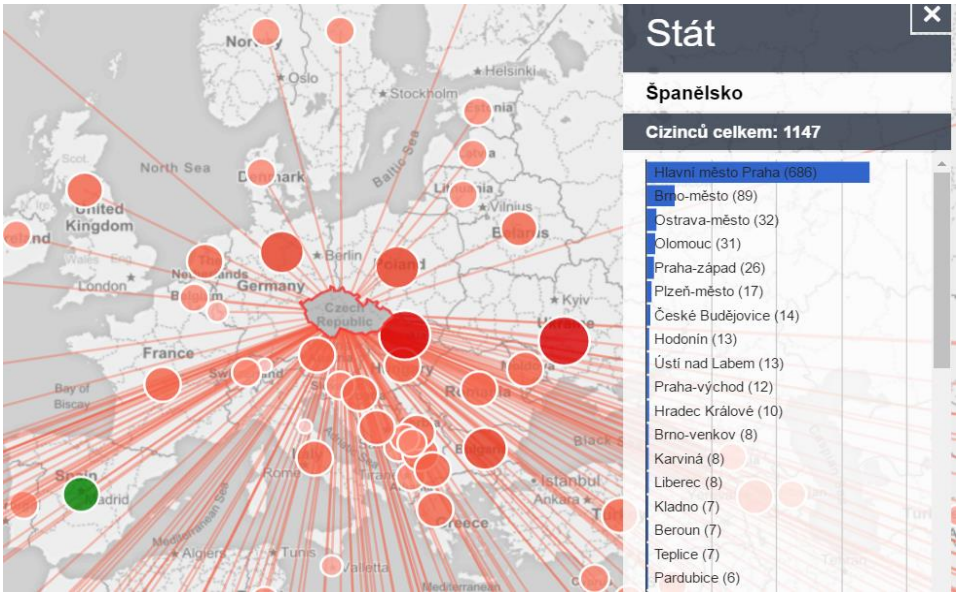
Figure 50 Main view of the Czech application



Source: mfox.cz

This web application also allow users to interact with the world map. By clicking on the countries map its shows the total number of Czech people living on the chosen country sorted by the larger region as it can be seen in the following figure.

Figure 51 Second view of the Czech application



Source: mfox.cz

5.3 Comparison of applications

The following table introduces an overview of the main features of each web application.

Table 11 Overview of the applications

Features	Statistics of Foreigners in the CZ	Spanish application	mfox.cz
Data of Specific country	Data set of foreigners in CZ	Data set of foreigners in Spain	Data set of foreigners in CZ
Data of Czech foreigners	Not supported	Not supported	Supports
Interactive Specific Map	Supports map of CZ	Supports map of SP	Supports map of CZ
Interactive World map	Not supported	Not supported	Supports
Line chart	Supports	Not supported	Not supported
Bar chart	Supports	Not supported	Supports
Tables	Supports	Not supported	Not supported
Statistics	Total number of foreigners by: • Type of residence • Regions and area • Top 6 countries • Demography events • Criminality • Illegal migration • Education • Acquisition of citizenship • Employment	Total number of foreigners: • By regions • By citizenship	Total number of immigration and migrations by: • Regions and area • By citizenship • Czech citizens abroad
Target users	• Foreigners • Government officers • Business people	Foreigners in Spain	• Foreigners in CZ • Czech citizens
Export data	Not supported	Not supported	Not supported

5.4 SWOT analysis

To evaluate the internal strengths and weaknesses, as well as the external opportunities and threats of this application SWOT analysis was used.

Internal Strengths

- User-friendly interface.
- Interactive Map, Line and Bar charts.
- Provides meaningful statistics in order to make an useful predictions and conclusions.
- Developed using Responsive design.

Internal weaknesses

- Manual downloading of data set from the CZSO website.
- Manual updating and collecting data.
- Does not allow to export data in CSV, Excel or JPEG

External opportunities

- New technologies utilized to improve user experience.
- New design to provide statistics.
- By passing and by providing more efficient means.

External threats

- Even though there are no similar web services yet, there is a possibility that they will be introduced in the market in the new future.
- If CZSO will stop providing the information openly, the workflow of the data would change causing the service to have no information to work with.

6 Conclusion

The main goal of the thesis was to analyze, design and develop a web application using open data, which was successfully developed by using open data sets from the Czech Statistical Office (CZSO) which makes the statistics more understandable in the eyes of any user without the need to have knowledge in statistics because users has the options to interact with the Maps and Charts to focus on the statistic they are interested in.

In order to accomplish a partial goal, there was a brief analysis of public entities such as: Otevrenadata.cz, Nadace Open Society Fund, Ministry of the Interior of the Czech Republic and mainly about Czech Statistical Office CZSO covering the foreigner section. Furthermore concepts about open data and how they can be useful in different areas was explained with an example of how it benefits the application in the Czech Republic and EU. Software development process and system development life cycle were also described.

Furthermore, in order to understand how this application was developed and how the downloaded data sets were used, there was a detailed step by step explanation of the whole process from designing and developing the system called *"Foreigners in the Czech Republic"*, which provides meaningful statistics by using an interactive Map, Line and bar charts.

"Foreigners in Czech Republic" web application supports all kind of devices such as Desktop, Tablets and Mobile phones because it was developed using a responsive design. Taking into consideration that in this generation everyone for their comfort are using smaller devices instead of a traditional desktop computer. This completed application was running on the university server from early February 2017. http://app.csita.cz/Statistics/

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8 Appendix

JS code 1. Complete code of the Highcharts function for the home page.

```
<div class="col s8 center">
    <h2>Trend in the number of foreigners in the CR by type of residence</h2>
    <div id="graph" style="height: 420px"></div>
    <script>
        $(function () {
            Highcharts.chart('graph', {
                chart: {type: 'column' },
                title: {text: false },
                xAxis: {
                  categories: ['1993', '1994', '1995', '1996', '1997', '1998', '1999', '2000', '2001', '2002', '2003',
                  '2004', '2005', '2006', '2007', '2008', '2009', '2010', '2011', '2012', '2013', '2014', '2015'] },
                yAxis: { min: 0, title: {
                        text: 'Number of foreigners' },
                    stackLabels: {enabled: true,
                        style: {fontWeight: 'bold', color: (Highcharts.theme && Highcharts.theme.textColor) || 'gray'
                        }}
                },
                legend: {
                    align: 'right', x: 0, verticalAlign: 'top', y: -10,floating: true,
                    backgroundColor: (Highcharts.theme && Highcharts.theme.background2) || 'white',
                    borderColor: '#CCC', borderWidth: 1, shadow: false
                },
                tooltip: {headerFormat: '<b>{point.x}</b><br/>',
                    pointFormat: '{series.name}: {point.y}<br/>Total: {point.stackTotal}'
                },
                plotOptions: {
                    column: { stacking: 'normal', dataLabels: {
                            enabled: false, color: (Highcharts.theme && Highcharts.theme.dataLabelsColor) || 'white' }
                    }
                },
                series: [{
                    name: 'Long-Term Residence over 90 days ',
                   data: [46070,71179,119965,152764,153514,155835,162108,134096,140978,156359,159577,154827,167714,
                   182271,234803,265374,252144,235339,237745,223491,202632,199511,204630]
                }, {
                    name: 'Permanent Residence',
                    data: [31072,33164,39242,46388,56797,64352,66754,66855,69816,75249,80844,99467,110598,139185,
                    157512,172191,180359,188952,196408,212455,236557,249856,260040]
                }]
            });
        });

    </script>
    <p class="source-title">Source: Directorate of Alien Police Service MI CR</p>
</div>
```

JS code 2. Highcharts function for the South Bohemian Region region (Line Chart).

```
<script>
    $(document).on('click', '.kraj', function() {
        var el = $('.click');
        var className = el.attr('class');
        var region = className.split(' ')[1];
        $('.kraj-tabulka').addClass('display-none');
        $('.kr-' + region).removeClass('display-none');

        new Chartist.Line('#chart-jihocesky', {
            labels: ['2002', '2003', '2004', '2005', '2006', '2007', '2008', '2009',
            '2010', '2011', '2012', '2013', '2014', '2015'],
            series: [[8698,9660,9954,10595,12584,15171,16560,15415,15037,14894,14838,15200,15366,16390]]
        }, {low: 0, plugins: [ Chartist.plugins.ctPointLabels({ textAnchor: 'middle'  })  ]
        });
        $(document).on('onmouseover', '.kraj', function () {
        $('kraj').addClass('kraj_hover'); });
</script>
```

JS code 3. Highcharts function for the South Bohemian Region region (Bar Chart).

```
<div class="kraj-bar kr2-jihocesky display-none">
    <p class="region_names"><center>Total by area and district</center></p>
    <div id="graph2" style="height: 400px"></div>
        <script>
        $(function () {
            Highcharts.chart('graph2', {
                chart: { type: 'column' },
                title: { text: null },
                subtitle: { text: 'NUTS3'   },
                xAxis: { categories: ['2002','2003','2004','2005','2006','2007','2008','2009',
                '2010','2011','2012','2013','2014','2015'],
                crosshair: true },
                yAxis: { min: 0,
                    title: {text: 'Foreigners'  } },
                tooltip: {
                    headerFormat: '<span style="font-size:10px">{point.key}</span><table>',
                    pointFormat: '<tr><td style="color:{series.color};padding:0">{series.name}: </td>' +
                        '<td style="padding:0"><b>{point.y:.0f} </b></td></tr>',
                    footerFormat: '</table>',
                    shared: true, useHTML: true     },
                plotOptions: { column: { pointPadding:0.1, borderWidth: 0.1 }},
                series: [{
                    name: 'České Budějovice ',
                  data: [2954,3243,2826,3075,3932,4716,4935,4737,4726,4855,4970,5121,5130,5391] }, {
                    name: 'Český Krumlov ',
                    data: [1618,1717,1929,2123,2364,2737,2844,2791,2867,2734,2606,2660,2638,2706] }, {
                    name: 'Jindřichův Hradec ',
                    data: [919,1084,1212,1261,1278,1431,2052,1777,1667,1667,1621,1638,1650,1729] }, {
                    name: 'Písek ',
                    data: [590,631,689,754,903,1056,1137,1048,1065,1099,1163,1286,1419,1728]},{
                    name: 'Prachatice ',
                    data: [750,830,964,961,997,1159,1248,1213,1171,1093,1079,1112,1081,1203] },{
                    name: 'Strakonice ',
                    data: [1215,1450,1608,1543,2085,2870,3010,2413,2027,1860,1767,1742,1773,1870] },{
                    name: 'Tábor ',
                    data: [652,705,726,878,1025,1202,1334,1436,1514,1586,1632,1641,1675,1763]}]
            }); });
        </script>
    <p class="source-title">Source: Directorate of Alien Police Service</p>
</div>
```

JS code 4. responsive navigation bar

```
(function($) {
  $.fn.menumaker = function(options) {
      var cssmenu = $(this), settings = $.extend({
        title: "Menu",
        format: "dropdown",
        breakpoint: 1150,
        sticky: false
      }, options);

      return this.each(function() {
        cssmenu.find('li ul').parent().addClass('has-sub');
        if (settings.format != 'select') {
          cssmenu.prepend('<div id="menu-button">' + settings.title + '</div>');
          $(this).find("#menu-button").on('click', function(){
            $(this).toggleClass('menu-opened');
            var mainmenu = $(this).next('ul');
            if (mainmenu.hasClass('open')) {
              mainmenu.hide().removeClass('open');
            }
            else {
              mainmenu.show().addClass('open');
              if (settings.format === "dropdown") {
                mainmenu.find('ul').show();
              }
            }
          });
```

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      multiTg = function() {
        cssmenu.find(".has-sub").prepend('<span class="submenu-button"></span>');
        cssmenu.find('.submenu-button').on('click', function() {
          $(this).toggleClass('submenu-opened');
          if ($(this).siblings('ul').hasClass('open')) {
            $(this).siblings('ul').removeClass('open').hide();
          }else {$(this).siblings('ul').addClass('open').show(); } });
      };
      if (settings.format === 'multitoggle') multiTg();
      else cssmenu.addClass('dropdown');
    } else if (settings.format === 'select')
    { cssmenu.append('<select style="width: 100%"/>').addClass('select-list');
      var selectList = cssmenu.find('select');
      selectList.append('<option>' + settings.title + '</option>', {
                                                    "selected": "selected",
                                                    "value": ""});
      cssmenu.find('a').each(function() {
        var element = $(this), indentation = "";
        for (i = 1; i < element.parents('ul').length; i++)
        {indentation += '-';  }
        selectList.append('<option value="' + $(this).attr('href') + '">' +
        indentation + element.text()+ '</option');
      });
      selectList.on('change', function() {
        window.location = $(this).find("option:selected").val(); });  }
    if (settings.sticky === true) cssmenu.css('position', 'fixed');
    resizeFix = function() {
      if ($(window).width() > settings.breakpoint) {
        cssmenu.find('ul').show(); cssmenu.removeClass('small-screen');
        if (settings.format === 'select') { cssmenu.find('select').hide(); }
        else {cssmenu.find("#menu-button").removeClass("menu-opened");  }
      }
      if ($(window).width() <= settings.breakpoint && !cssmenu.hasClass("small-screen")) {
        cssmenu.find('ul').hide().removeClass('open'); cssmenu.addClass('small-screen');
        if (settings.format === 'select') {cssmenu.find('select').show();  }
      }};
    resizeFix();
    return $(window).on('resize', resizeFix);
  });  };
})(jQuery);
```