IMPLEMENTING SMART CITY SOLUTIONS: SMART CITY MAP AND CITY DROP

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*R*epresenting the new trend in city development, smart city represents an emerging topic. The paper provides an overview of the smart city concept, focusing on the developing of the subject in Romania and presenting two smart city applications developed both part as smart city solutions, and as the Smart City Map (that provides geospatial information services and accessible data for the general public to search and find out information on specific subjects such as geographic locations, buildings, natural environment and public facilities) and City Drop application (which facilitates access and guides users to local cultural places and events). Smart City solutions benefits are efficient resource utilization, increased quality of life, higher levels of transparency and openness towards citizens.

Keywords: Smart City, Smart Solution, City Development, Smart Governance.

INTRODUCTION

Smart City represents the new trend in city development and governing by applying new sets of technologies that enables the citizens to freely access information about their city. Smart City represents a very broad term that encompasses a lot of domains: environment monitoring, traffic analysis, utilities monitoring, public transportation, incident reporting and many more. Gathering all the data from the aforementioned domains enables the city governance to make improvements on infrastructure and overall optimising its assets. Also it enables a more transparent communication between the governance and its citizens.

A city becomes a Smart City if it has some key components that enable the centralisation of the above mentioned data. These components can take many shapes and forms from a simple website to more complex and context aware mobile

applications and specialised hardware. Another important aspect refers to the accessibility of the data in such way that the system should be freely accessed by the citizens and should allow them to propose modifications and corrections. By enabling the contribution of the citizens more angles are achieved regarding an information and it's easier to obtain more data from citizens.

Addressing the challenges above, the overall objective of the project "Creating R&D laboratories to develop big data products for IOT applications", accessed by ANAGRAMA, is to develop innovative products for Smart Cities. Based on Application Program Interface (API) and Backend & Content Management System (CMS), four applications have been developed: Smart City Map, Buy Local, City Drop and Jobs Nearby. Two of them, Smart City Map and City Drop are presented in the next chapters.

SMART CITY CONCEPT

Smart City represents, as Albino et al. (2015) describes, a collection of paradigms spread across different domains: Economy, People, Governance, Mobility, Environment and Living.

Smart Economy refers to the level of entrepreneurship and innovative spirit of the citizens quantified by the emergence of successful local businesses. It also allows easy accessibility to jobs and improves productivity by ensuring high mobility and high work standards.

Smart Mobility implies a well-planned, emission free local transport system that allows fast commuting and a cleaner environment. A Smart City should provide infrastructure for non-mechanised transportation (bicycle, scooter, etc.) that can be combined with public transportation. Also the city should provide intermodal systems comprised of parking lots for cars at the city limits enabling the citizens that live in the suburbs to switch to the public transport. Smart Mobility refers also to ICT (Information and Communication Technology) transport by implementing the latest communication technologies thus ensuring fast internet over wire and wireless solutions. Last but not least, the city should be able to sustain its transport system by periodically improving and optimising it.

Smart Environment refers to the quality of the environment inside and surrounding the city. This implies a good air quality, water treatment stations, clean garbage disposal, recycling programs and also an ecological awareness of the citizens which can be achieved by education.

Smart People implies a diversification of education systems, from the traditional public systems to extracurricular programmes designed to better educate and open an individual. A high accent is put on open-mindedness and the ability to be ethnic plural.

Smart Living represents a collection of indicators that refers to the main points of having a high quality of life: good health conditions, high individual security, good housing conditions, education facilities, cultural and leisure facilities. All of the above mentioned should be generally accessible by any individual at any given moment. Another important aspect regarding this indicator is tourist attractiveness which can substantially increase city revenue and can help grow local businesses.

Smart Governance implies that all of the citizens should be aware about the political status of the city and also be proactive regarding the governance. This can be achieved by integrated solutions that allow for a better communication between the citizens and the government thus opening and ensuring a more transparent public administration. Another important aspect represents the ability of the public administration to collect its taxes online and by slimming the bureaucracy ensuring a higher productivity.

One of the biggest challenge in achieving the title of Smart City is the mentality of both the governance and the citizens. They should be technology literate and open towards learning new ways of living and that is because, in order to achieve a Smart City, it implies a behaviour change for both parties. Another challenge represents an economical one because implementing the necessary systems can prove to be costly and demands extensive investment (ex.: cleaner, electric buses for public transportation to replace old inefficient diesel ones).

The advantage of achieving all of the above are evident and by reaching this level of integration can lead to a guaranteed improvement in the quality of life and higher efficiency of public spending. In order to overcome the challenge of achieving such a goal, small steps can be taken in that direction. Such small steps are represented by the following two applications Smart City Map and City Drop which aim to push further the Smart Living aspect of a Smart City.

SMART CITIES IN ROMANIA

The Urban Europe 2020 strategy for smart sustainable and inclusive urban growth defines priorities and initiatives in areas such as Infrastructure and Electronic communications, Health, Transport and mobility, Education, culture, tourism, Smart administration, Smart businesses, Public safety and Green energy (Urban Agenda for EU – Pact of Amsterdam).

The analysis carried out by European Smart Cities Organization reveals evidence that some of most important cities in Romania rank behind average in smart city development (*Figure 1*). The results and performance of implemented smart solutions in Romanian cities should be improved in order to achieve a higher overall score.

Table no. 1

EU Smart Cities ranking (www.smart-cities.eu/?cid=3)

Country	City	Eco	Peo	Gov	Mob	Env	Liv	Rank
LU	**Luxembourg**	1	18	56	4	16	4	1
DK	**Aarhus**	2	3	6	3	19	27	2
...	...	…	…	…	…	…	…	…
HU	**Miskolc**	69	71	39	63	69	70	69
PL	**Suwalki**	67	70	55	57	71	68	70
EL	**Larisa**	58	61	76	74	22	74	71
BG	**Ruse**	61	74	70	69	62	72	72
RO	**Sibiu**	74	76	62	73	74	56	73
EL	**Patrai**	59	55	77	77	35	77	74
BG	**Pleven**	62	73	64	76	70	73	75
RO	**Timișoara**	70	75	63	72	75	71	76
RO	**Craiova**	75	77	59	75	77	76	77

The ranking takes into consideration key indicators among which: smart economy, smart living, smart people, smart governance, smart mobility and smart environment. A comparison between smart city profiles of two Romanian cities Timisoara, Sibiu and the city of Graz in Austria reveals that we are one step behind average smart city development (*Table no. 1*).

Figure 1

Comparison between smart city profiles

Sursa: http://www.smart-cities.eu/?cid=5&ver=3.
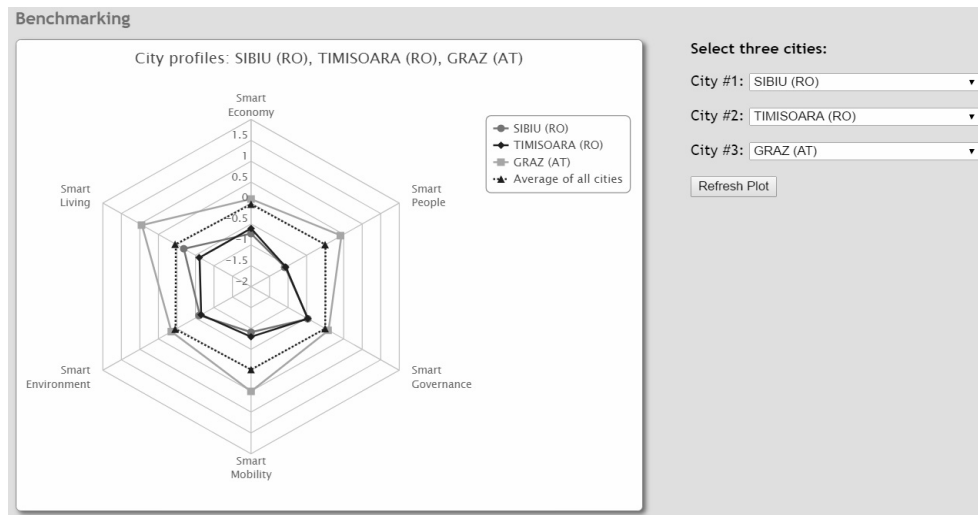
Urban development performance depends not only on the technical infrastructure, but also on the availability and quality of knowledge, communication and social infrastructure (Spiro, 2006).

At national level, a Smart City guide was published relying on **international best practices and solutions, emphasizing the** vision on smart cities, goals and objectives. The guide addresses aspects like interoperability, security, smart businesses, improved public administration, tourism, transport healthcare and smart eGovernment services.

In Romania there are several cities with initiatives in implementing smart city solutions such as Bucharest, Brașov, Sibiu, Alba Iulia, Timișoara, Craiova and Cluj-Napoca. These cities are relevant from an administrative, economic, cultural, tourist and industrial point of view.

Bucharest developed a "Plan for Urban Development" which includes several projects, targeting modernization through tramway network improvement, new parking spaces and a more efficient public transport. One of the smart city initiative achievements is a Traffic Management System for 103 intersections (Bucharest Smart City).

Sibiu city initiated a smart environment project called SMART CITY SIBIU Project which aims to promote smart solutions for energy generation and consumption, as well as an effective management of the electricity and heat consumption in selected areas of Sibiu. The project has a modular architecture consisting of central platform which monitors and orchestrates multiple applications (Smart City Sibiu).

Also Alba Iulia is the first Romanian city to be rated by the ratings agency Moody's. According to the   agency, Alba Iulia Municipality is a city with a strong institutional capacity for planning urban development and attracting finance for urban projects (Alba Iulia Smart City).

Brasov is one of the first European cities implementing a system that manages all its street lights through an integrated remote lighting management system. The project in Brasov included the implementation of the system over a large variety of street lighting fixtures, as well as Smart applications as environmental sensors, video cameras, panic buttons, and a municipality-wide Wi-Fi MESH network. The system constantly monitors key parameters, offering analysis and planning tools with the aim to reduce energy consumption and maintenance costs (Brașov Smart City).

For smart and sustainable growth of a city is important to promoting a more efficient use of resource, a competitive economy and an economy based on knowledge and innovation (Bătăgan, 2012). At national level there is a need to establish functional partnerships between all actors involved in a smart city ecosystem, whether we are talking about Public Administration, Private Companies, Professional Associations with a role in urban development and design. The collaboration between these entities will generate a coherent strategy, in line with the agenda defined by the Amsterdam Pact, with the needs of local communities and the technological capabilities of the ICT industry.

SMART CITY SOLUTIONS

Smart City solutions benefits are efficient resource utilization, increased quality of life, higher levels of transparency and openness towards citizens.This study proposes a case analysis and overview of two Smart City solutions: a Smart City Map and a City Drop application which facilitate access and guide users to local places and events.

Smart City Map – Intelligent City Map Application

Smart City Map provides geospatial information services and accessible data for the general public to search and find out information on specific subjects such as geographic locations, buildings, natural environment and public facilities.

Smart City Map – Intelligent City Map Application implemented by ANAGRAMA represents a multifunctional data hub, available online from a mobile terminal application. In addition to the incident reports sent directly, the application also provides localized information using the digital infrastructure of "CityDataPub". The software solution is developed so that Smart City Map Application is projected as a multi-level map, personalized for different needs and working with massive real-time data.

The Smart City Map software solution provides the following features:

- Incident Report;
- Free WiFi;
- Accessibility;
- Local Recycle – Recycle locally;
- CityTourism – Tourism in town.

The functionality specifications for each feature are detailed below.

Incident Report feature

The application provides to the users the ability to directly report to the authorities various incidents such as holes, damaged street lights, damaged signs or graffiti with description, image and geo-location and also provides the option to follow the evolution of such calls, having the following functionalities as shown in *Figure 2* described below.

- Search functionality – it provides the ability to search for incidents by geo-location or type incident;
- Map View – it provides the ability to view all incidents on a data map;
- Map Filters – it offers the choice between different filters to refine the displayed search results;
- Send Incident – it provides the ability to report incidents by sending via the application's interface an explanatory text and an image;
- Interactivity – it provides the ability to view each report in detail description / image, including whether the incident has been resolved or not.

Figure 2

**Incident Report (Anagrama – Smart City Map application)**
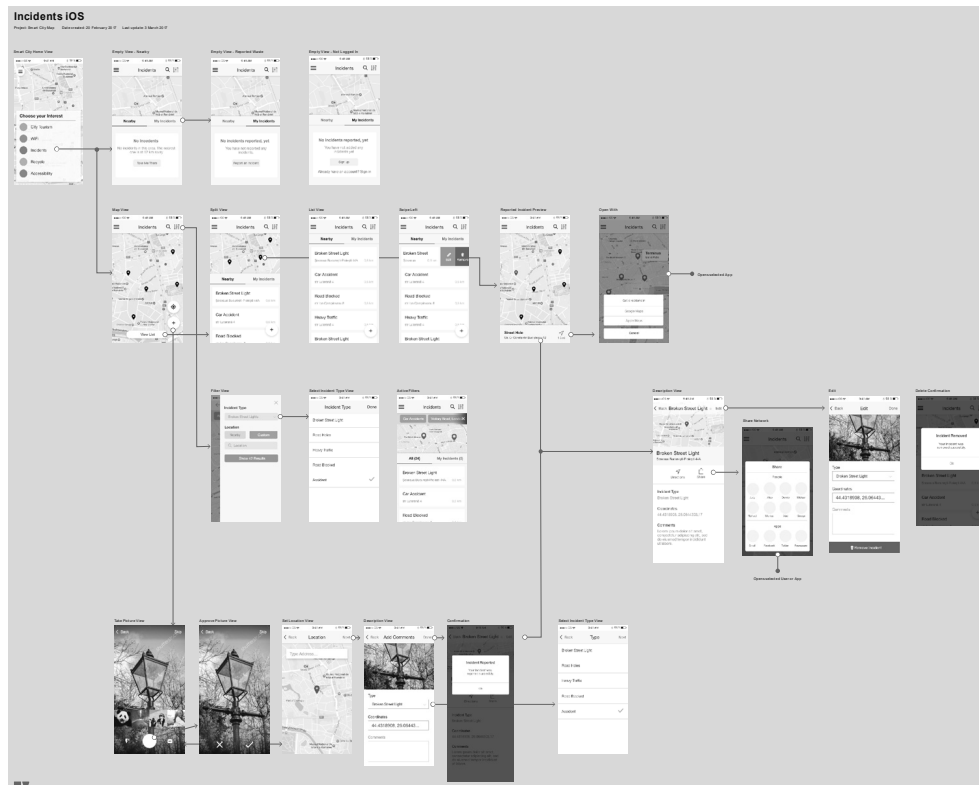
Free WiFi feature

The application searches and connects to free Wifi networks in the user area, taking into account the particularities of each device, with the following functionalities, as shown in *Figure 3* and described below.

- City database – it creates a database of all the city's free WiFi networks;
- Search – it offers the option to search for labelled WiFi or for Geo location;
- Map View – it provides the option to view all the WiFi networks on a data map;
- Networking – it provide users the option to publish their own WiFi networks through the application;
- Information Description – it proposes and offers the facility to access additional information about speed / accessibility / etc. for each network;
- WiFi Connection – it provides the option to use the available public codes in order to connect users to the nearby WiFi networks.

Free Wifi (Anagrama – Smart City Map application)
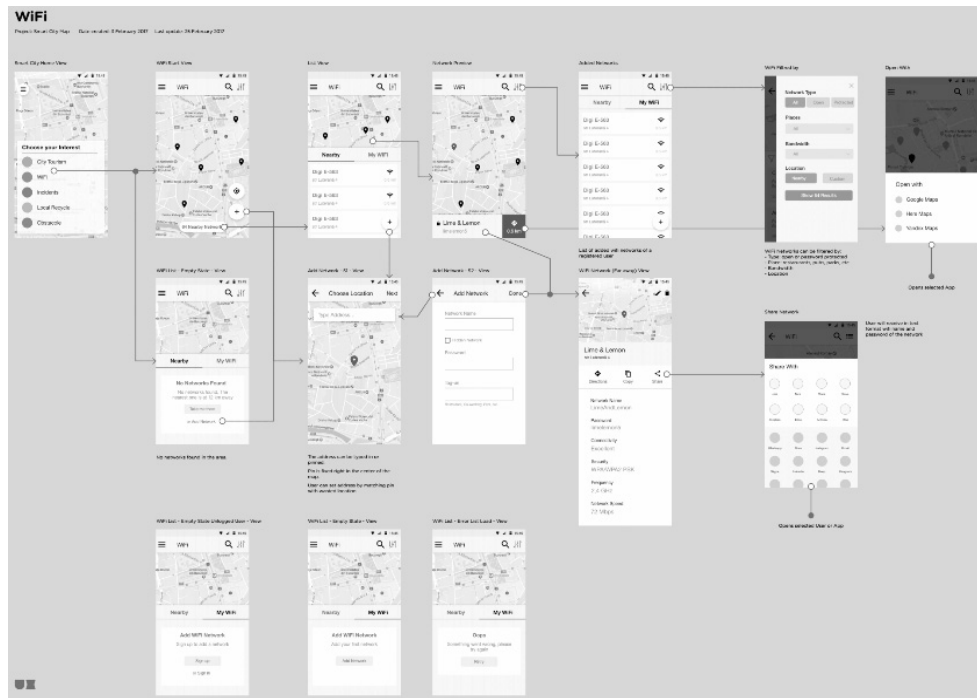

Accessibility feature

The application allows the search and discovery of buildings/ restaurants/ points of interest and also provides transport opportunities for visually impaired, hearing impaired or paralyzed people with the following functionalities as described below and shown in *Figure 4*:

• City-level database – it provides the option to store in a database all the locations with transport possibilities (public transport, taxis) at city level;

• Location Search – it provides the option to display nearby places or transport routes using its own GPS position;

• Search by Point of Interest – it provides the option to refine the search results by categories, points of interest or type of disability;

• Place Suggestion – it offers to the users the option to propose their own locations / transport possibilities and evaluation within the application in terms of accessibility and extra features;

• Map View – it provides the option to view unobstructed places on a data map;

• Route Planning / Navigation – it provides the option to use the integrated route planner in order to reach specific locations with suggested options for transport (barrier-free transport, transport public);

- Share Places – it offers the users the option to share recommended or not recommended places unknown to the community;
- Retrieval – it provides the option to customize the information according to users own needs by memorizing places and transport opportunities.

Figure 4

Accessibility (Anagrama – Smart City Map application)
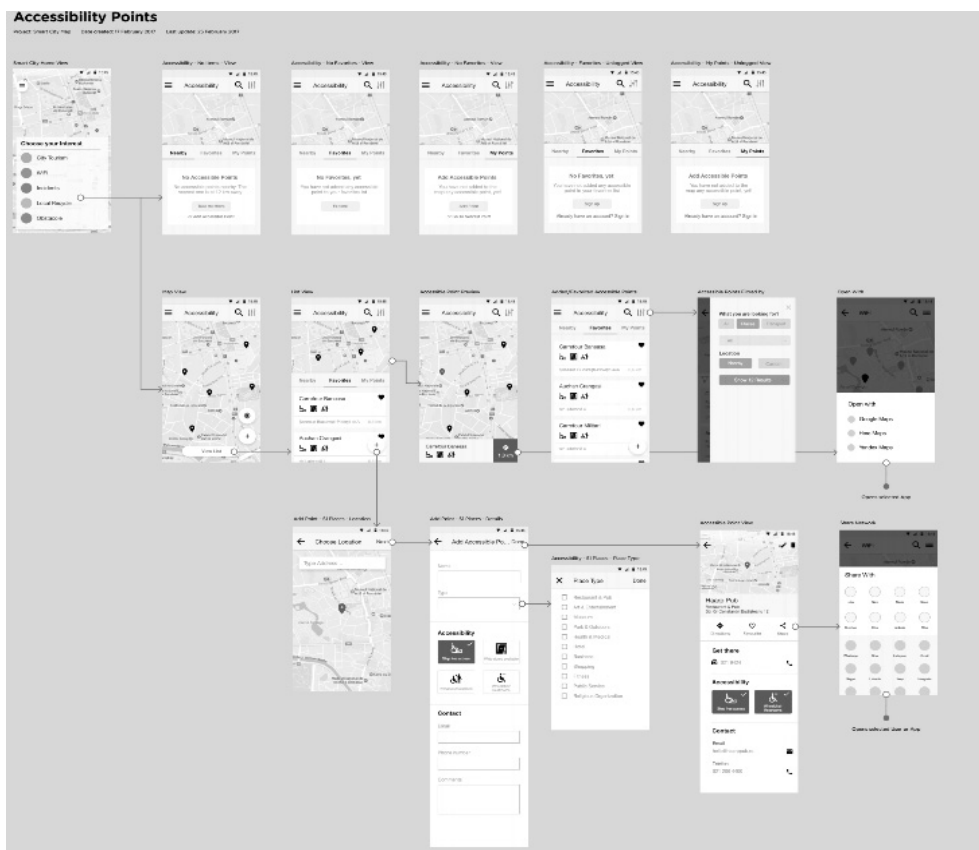
Local Recycle – Recycle locally feature

The application offers the opportunity to display the closest recycling centres, dumps or exchange centres using the geolocation function, having the following functionalities as described below and shown in *Figure 5*:

- Database – it provides the option to store in a database all the places/ information already existing;
- Search – it provides the option to search for geotags of recycling centres, exchange or nearby racks;

- Map View – it provides the option to view recycling locations in a data map;
- Trash Reports – it provides the option to send geo-localized reports.

Figure 5

Local Recycle (Anagrama – Smart City Map application)

City Tourism – City Tourism feature

The application provides an interactive map structured according to the needs of tourists that promotes events and local businesses, with the following functionalities as described below and shown in *Figure 6*:

- Search by Point of Interest – it provides the option to search by point of interest and to use route planner integrated into the operating system;
- Event Search – it provides the option to search for current events/ categories events;
- Map View – it provides the option to view POIs and locations events in a data map;
- Time Filter – it provides the option to filter events by visiting time;
- Event Lists – it provides the option to track events and create a customized schedule using bookmarks and lists;
- View Event Details – it provides the option to search for additional information about events, artists, program or tickets;
- Home Tag – it provides the option to apply a hotel/ room geolocation tag to find the way back using the route planner integrated into the operating system.

Figure 6

City tourism (Anagrama – Smart City Map application)

City Drop

In accordance with the cities necessity to create a better experience for citizens and tourists, "City Drop" is an interactive virtual guiding map introducing the points of interest of the city, detailing local cultural assets and social events for local residents and visitors. CityDrop Application implemented by ANAGRAMA – provides a software solution that will turn the city into a gigantic virtual library, through QR code stickers placed across the city (*Figure 7*).

This tool makes the decision-making process much more efficient for users as they can quickly and easily identify the best locations and events. Local residents or tourists can access, for example, classical literature or local art through these stickers placed in places like buildings, bus stops, park areas.

The application allows regular modifications of the content and hidden surprises such as free event cards are provided in order to encourage users to follow the new features. These characteristics make it a platform for public content and advertising.

Figure 7

**City Drop workflow (Anagrama – City Drop application)**
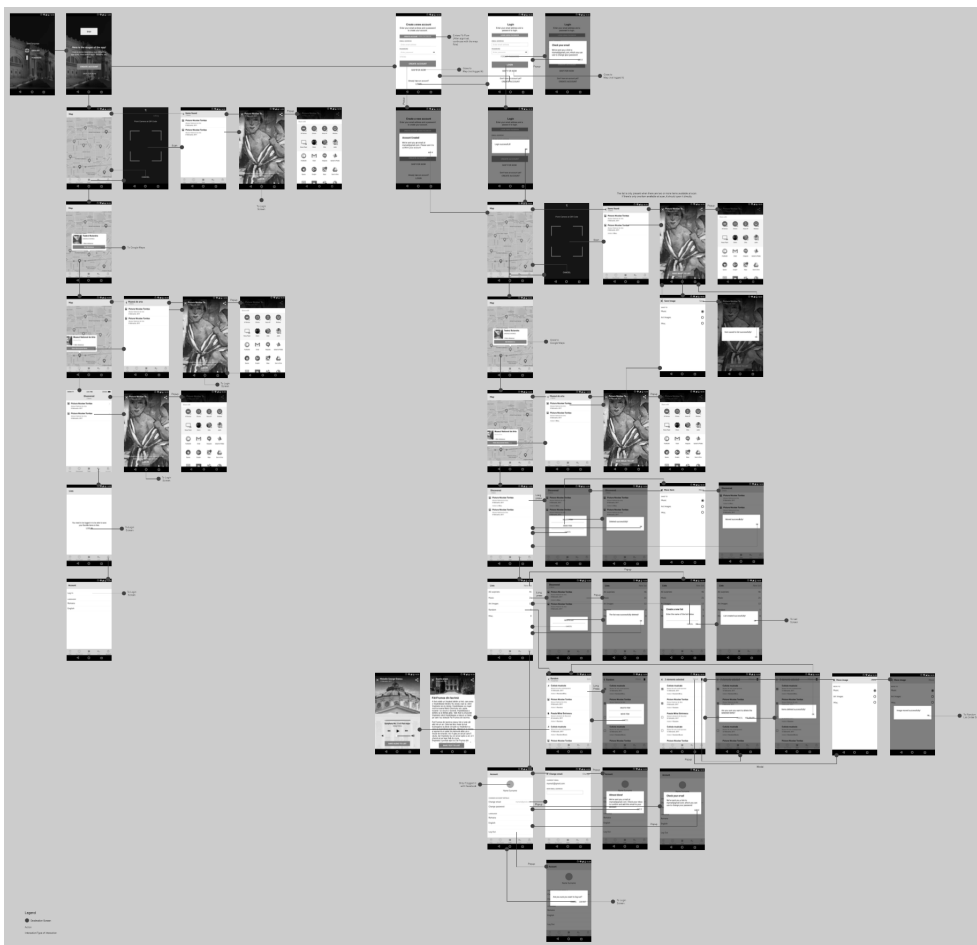
City Drop provides the following features:

• Discover the city – it provides the ability to scan QR codes (Figure 8) to access various location-based content such as music, literature, or art;

- Map Overview – it provides the ability to display QR codes already found on a map;
- Surprises – it provides the chance to randomly collect small rewards, such as free tickets, and also offers users the opportunity to access these surprises;
- Customization – it provides users the ability to create and manage their own lists, to navigate and sort the collected content;
- Social Integration – it provides users the ability to share the discovered content with their friends.

Figure 8

City Drop QR scan (Anagrama – City Drop application)
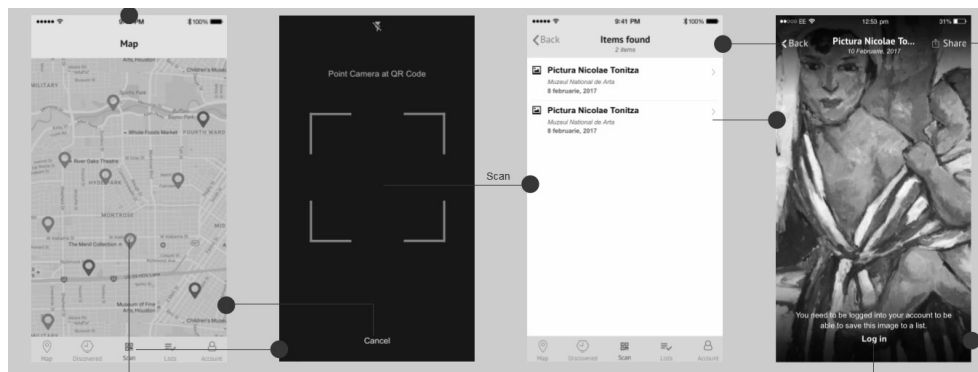
A scenario example for the application is the following: a tourist discovers a QR code in a random city location, and wants to try CityDrop. After downloading and installing one of the versions – IOS or Android – he starts the application, which provides two possibilities: scan the code either as an authenticated user, thus create an account, either without registering. After creating an account he arrives to a location with a QR code, scans it and instantly saves the displayed item to a list. A list of created items can be customized, edited and sorted.

The application is useful for both users, because it provides them constantly updated information concerning art and cultural events, and for the organizers as they can promote their events.

Support technologies

The support technologies for the applications development on server side are: PHP used as programming language, CodeIgniter as a support library in PHP and Bootstrap as a support library for layout and design.

Mobile applications are developed in native programming languages thus on the IOS operating system Swift is used and Java is used on Android. The ReactJS is used as a support library for controlling graphic interface elements.

Innovative concepts resulting from the implementation of these solutions, based on Smart City technology, complemented by a public data platform and an interoperability platform can significantly help local government, citizens, tourists and the local business environment through high-availability and innovative services.

CONCLUSIONS

The benefits are a more transparent and reactive approach to its citizens' needs. It becomes easier to navigate for visitors, and more serendipitous for locals. City officials and municipal governments are provided with a completely new way to connect with citizens and visitors and a city that is more connected to its people works and feels better.

Small steps are being made towards the ultimate goal, Smart City, by improving on the Smart Living aspect of it. This steps are represented by the two above illustrated applications which enables the citizens of a city to be proactive regarding incidents that are occurring around them (Smart City Map) and the possibility to increase the awareness for local events and history which is ensured by the City Drop application.

Acknowledgment

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Urban Agenda for EU – Pact of Amsterdam available online at http://ec.europa.eu/regional_policy/sources/policy/themes/urban-development/agenda/pact-of-amsterdam.pdf.

Reprezentând noul trend în dezvoltarea urbană, oraşele inteligente reprezintă un subiect la zi. Articolul oferă o viziune de ansamblu asupra conceptului oraş inteligent, concentrându-se pe dezvoltarea subiectului în România şi prezentând două aplicaţii tip oraş inteligent, dezvoltate parte ca soluţii smart city, parte ca Harta Smart City (care oferă servicii de informare geospaţială şi date accesabile, ca publicul să poată căuta şi găsi informaţii pe subiecte specifice ca locaţie geografică, clădiri, mediu natural şi facilităţi publice). O altă aplicaţie este cea numită City Drop (care facilitează accesul şi îndrumă utilizatorii către locaţii şi evenimente locale culturale). Beneficiile soluţiilor Smart City sunt: utilizarea eficientă a resurselor, o calitate mai bună a vieţii, niveluri crescute de transparenţă şi deschidere către cetăţeni.

Cuvinte-cheie: *oraş inteligent, soluţii inteligente, dezvoltare urbană, guvernare inteligentă.*