# SMART CITY APPLICATIONS BUILT ON BIG DATA TECHNOLOGIES AND SECURE IOT

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**Abstract**
*Smart city represents an emerging topic because efficient city management is beneficial for both government and private sector businesses. IoT envisions to connect billions of sensors to the Internet and expects to use them for efficient and effective resource management in Smart Cities. An organisation collects data analyses it and uses the results as an input for decision making processes. The paper provides an overview of the smart city concept relying on IoT and Big Data technologies, an overview on Smart City development in Romania and describes four Smart City national solutions. Their benefits are efficient resource utilization, increased quality of life, higher levels of transparency and openness towards citizens. A smart city uses digital technologies or information and communication technologies (ICT) to enhance quality and performance of urban services to make lives of citizens better. 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.*

**Key words:** *Smart City, Big Data, IoT, City Development, Smart Governance*

**JEL Classification:** *R11*

## I. INTRODUCTION

A smart city is a place where traditional networks and services are made more flexible, efficient and sustainable with the use of information, digital and telecommunication technologies, to improve its operations for the benefit of its inhabitants. In other words, in a smart city, the digital technologies translate into better public services for inhabitants, and for better use of resources while impacting the environment less (Mohanty, 2016). Also it enables a more transparent communication between the governance and its citizens. Smart City represents the new trend in city development and governing by applying new sets of technologies that enable the citizens to freely access and use information and applications from their city.

Lately, technologies such as BigData and IoT have enabled more innovative and creative developments for smart cities. This has been a very important development in the era of information and technology.

## II. SMART CITIES PARADIGM

Smart City represents, as Albino et. al. (2015) describe, a collection of paradigms spread across different domains: Economy, People, Governance, Mobility, Environment and Living. The concept encompasses a lot of domains: environment monitoring, traffic analysis, utilities monitoring, public transportation, incident reporting and many more. Collecting all the data from the aforementioned domains enables the city governance to make improvements on infrastructure and overall optimising its assets.

A Smart City must include key components that enable the centralisation of the data, components that can take many shapes and forms from a simple website to more complex and context aware mobile applications and specialised hardware. On the other hand the accessibility of the data should be guaranteed 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 it can ensure that more angles are achieved regarding an information and also making it easier to obtain more data from citizens.


**Figure 1 - An overview of Smart City(http://www.iotnet.eu/wp/solutions/)**

This rapid increase of urbanization raises new infrastructure challenges for governments and municipalities. As cities grow and expand their services, governance and management are becoming more and more complex. As a consequence, cities need to be adapted to address the social, economic, engineering and environmental challenges of these transformations. The cities need to become smart to properly face the challenges.

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 and will be addressed in the next chapters.

## III. BIG DATA FROM THE INTERNET OF THINGS

The Internet is the infrastructural backbone of the massive exchange of data that is produced and exchanged every second. In 2015, mankind produced as much data as it created in all the previous years of human civilization. And still, data generation continues to grow exponentially. Today, the amount of worldwide data produced doubles every 12 months. Not far in the future, it will double every 12 hours. (Duarte, 2016)

Big Data in information technology is a collection of data sets so large and complex that it becomes difficult to process using on-hand database management tools or traditional data processing applications. The concept addresses large volumes of automatically generated data from different data sources; centralized or self-contained that can come from different autonomous sources. Given that traditional databases have reached limits when analyzing these data, dedicated solutions should be considered. (Alvarez, 2017)

In recent approaches, large data is characterized by principles known as Volume, Variety, Speed and Veracity 4V. (Wamba, 2015)

The challenges include capture, storage, search, sharing, analysis, and visualization. With such data high-volume, high-velocity, and/or high-variety information assets that require new forms of processing to enable enhanced decision making, insight discovery and process optimization.

Examples of such data include both structured data and unstructured data collected from various sources such as IoT systems, hardware systems. The volume and diversity of data make it challenging to collect, store, retrieve and analyze the information. IoT assumes that data is collected from several types of sources in constrained environments. Big Data generated by IoT brings as an immediate promise real-time responses and predictions and personalized options.

To deliver new opportunities, according to EMC's Bill Schmarzo, a new generation of IoT applications is required to address specific business needs such as: predictive maintenance; loss prevention; asset utilization; inventory tracking; disaster planning and recovery; downtime minimization; energy usage optimization; device

performance effectiveness; network performance management; capacity utilization; capacity planning; demand forecasting; pricing optimization; yield management; and load balancing optimization. (McLellan, 2015

## IV. SMART CITY NATIONAL INITIATIVES

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.

An 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. The results and performance of implemented smart solutions in Romanian cities should be improved in order to achieve a higher overall score. 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.

A Smart City is a city well performing in 6 key fields of urban development (Fig. 2), built on the 'smart' combination of endowments and activities of self-decisive, independent and aware citizens. 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).

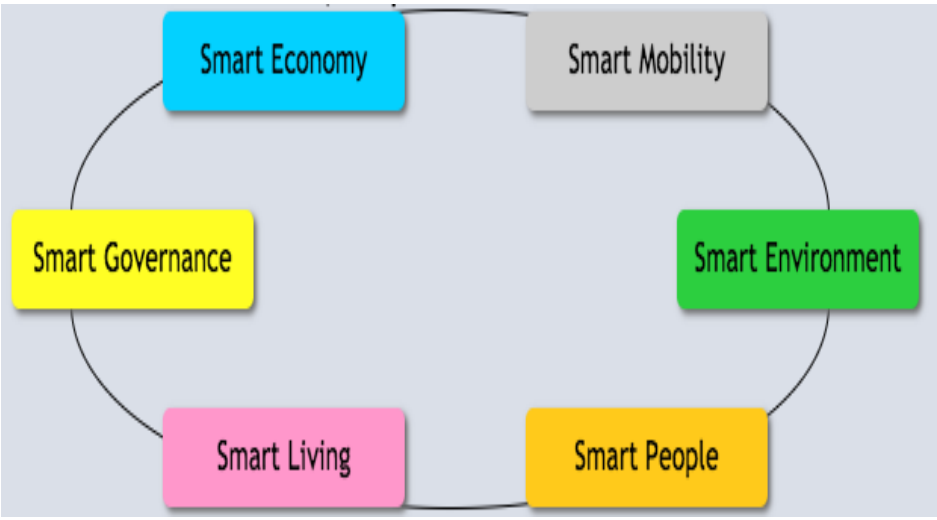


**Figure 2 Smart City model**

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, Brasov, Sibiu, Alba Iulia, Timisoara, Craiova and Cluj-Napoca. These cities are relevant from an administrative, economic, cultural, tourist and industrial point of view.

For smart and sustainable growth of a city is important to promoting a more efficient use of resource, a competitive economy and an economy base on knowledge and innovation (Bătăgan, 2012).

## V. MART CITY CASE STUDIES

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.

### A. 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; LocalRecycle - Recycle locally; CityTourism - Tourism in town.

The *Incident Report* feature 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: search, map view, map filters, send incident, interactivity.

The *Free WiFi* feature searches and connects to free Wifi networks in the user area, taking into account the particularities of each device, with the following functionalities: city database, search, map view, networking, information description, Wifi connection.

The *Accessibility* feature 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 : City-level database, location search, search by point of interest, place suggestion, map view, route planning/navigation, share places, retrieval.

The *Local Recycle* feature offers the opportunity to display the closest recycling centres, dumps or exchange centres using the geolocation function, having the following functionalities: database, search, map view, trash reports.

The *City Tourism* feature provides an interactive map structured according to the needs of tourists that promotes events and local businesses, with the following functionalities: search by point of interest, event search, map view, time filter, event lists, view event details, home tag.

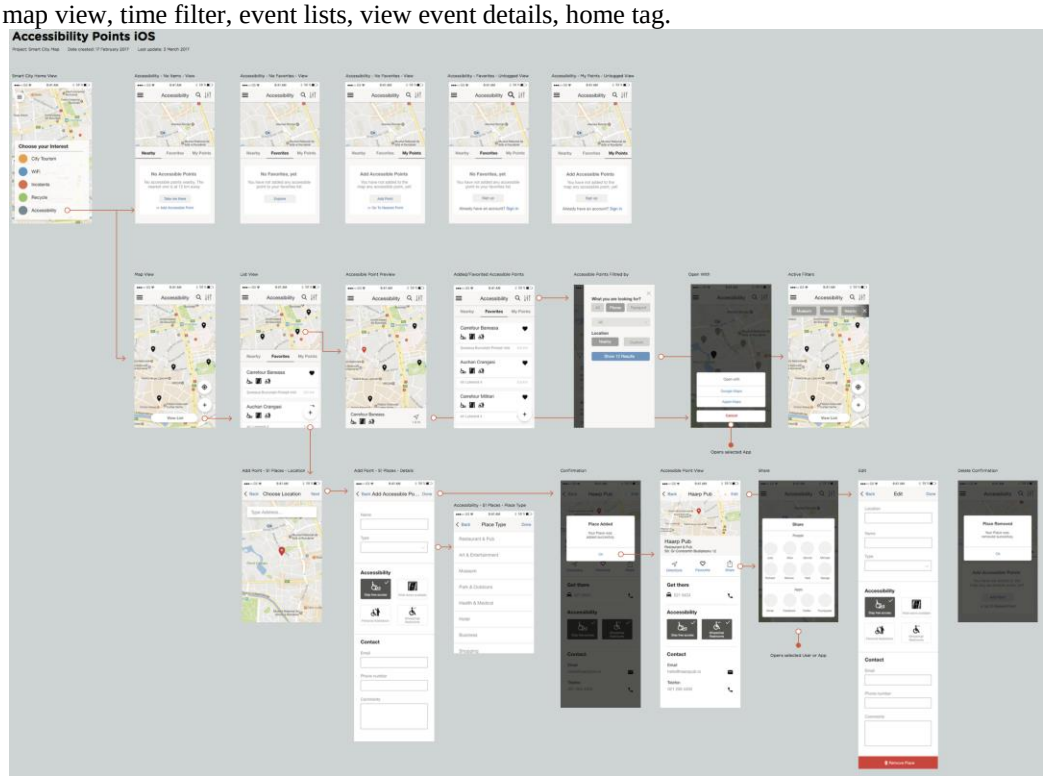


**Figure 3 Smart City Map Accessibility feature**

### B. 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.

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.

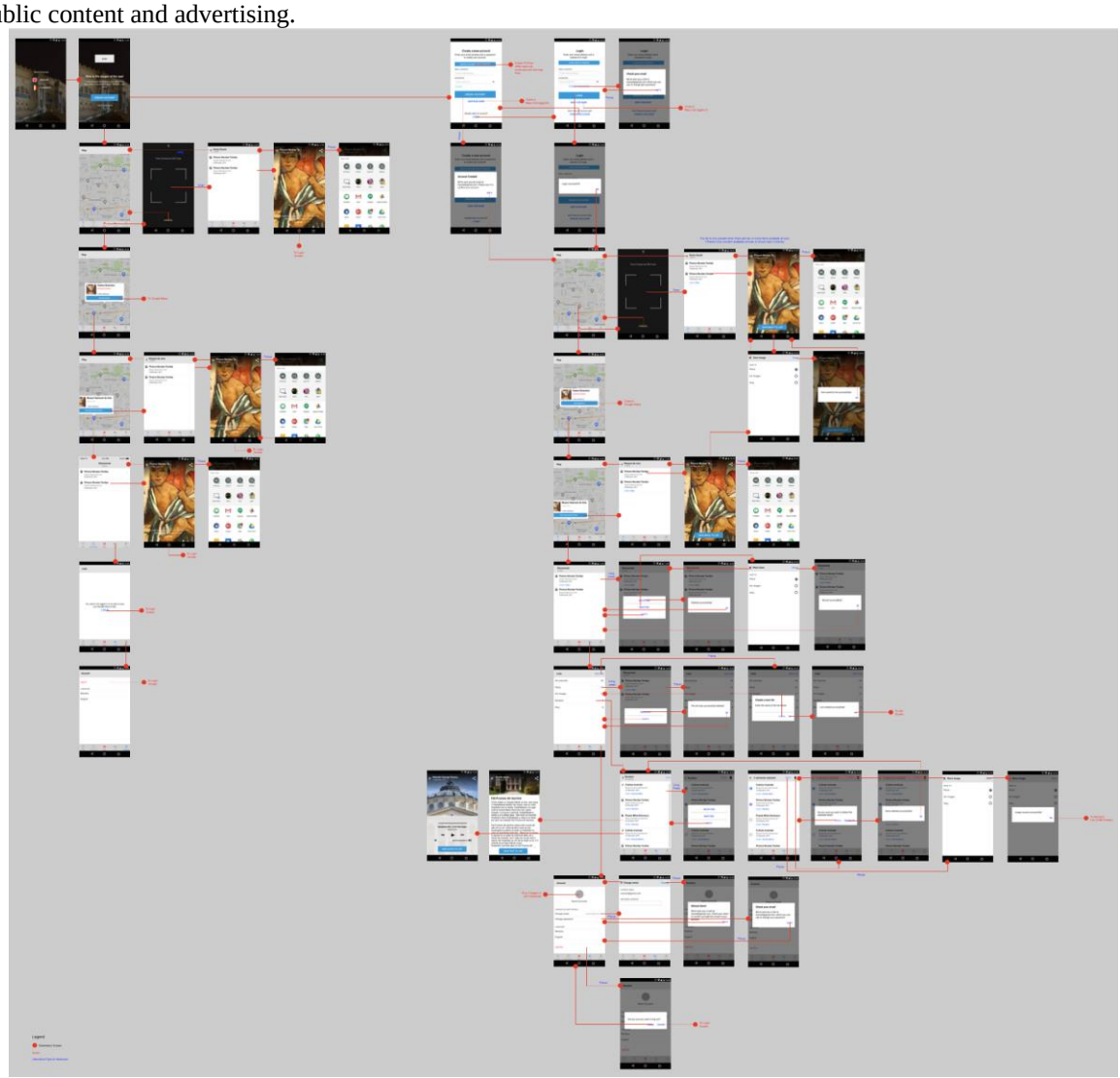

**Figure 4 CityDrop workflow**

City Drop provides the following features: Discover the city, map overview, surprises, customization, social integration.

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.

### *C.* JOBS-NEARBY

With *Jobs-Nearby*, the local job market gets a fast and flexible tool to connect job-seekers and enterprises that are hiring in real-time. Job offers can be displayed on a map, filtered by your location, skills or payment.

The optional Community-Profiles allow to bookmark or share interesting offers and provide an individual profile of participating job-seekers and enterprises.

The users' authentication is accomplished by e-mail and password, after creating a user account. To keep up with the faster pace in the on-line, the account can be created using Facebook – the application is integrated with the FB authentication API and taking data directly from there. After creating an account, the user can start filling his/her profile. The profile data are general, but also strictly professional, such as the previous expertise from each job, foreign languages, education, etc.

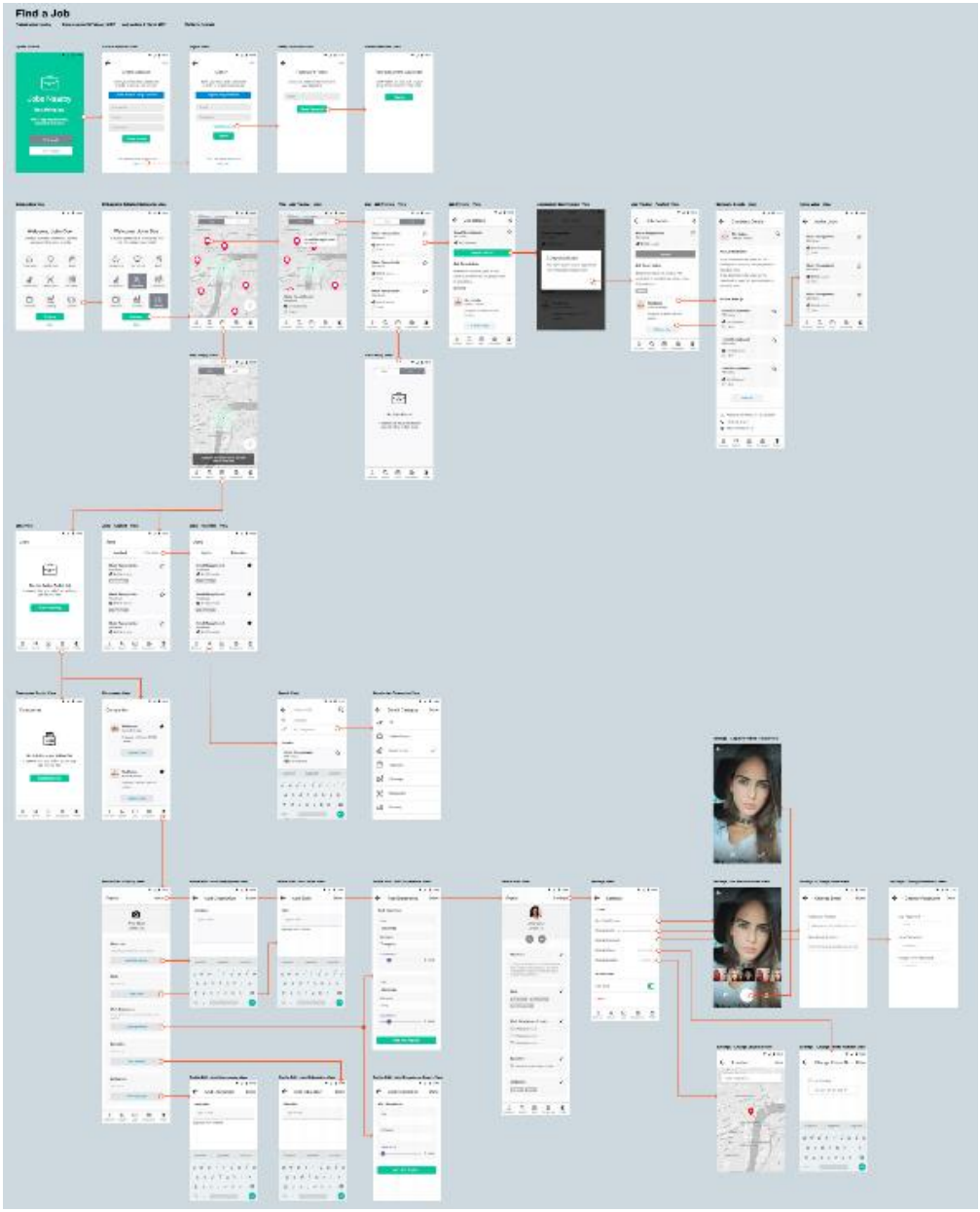


**Figure 5 Jobs-Nearby workflow**

### D. BUY LOCAL

Smart City solution Buy Local connects users to nearby shops, aiming to increase awareness and transaction of local shops via a mobile app and website. Combined with details about opening hours and fitting shopping areas, citizens have an easy and up-to-date overview about local shopping-possibilities. By entering a search-request or choosing a category, the results are listed location-based, nearest result on top. Enterprises can use the website-interface to publish their products and related information.

Key features of Buy Local application are:

- Search by Location - search local shops for products and brands

- Map Overview - overview about products and sales of nearby stores
- Filter-Functionality - filter results by distance, brand or shop-category
- Detail-View - provide price lists, contact-information about the product and related products and brands
- Publishing Portal - store owners can publish their current products and promote sales Key Benefits
- Strong local focus due to the city-based range of enterprises
- Additional promotion-platform for local enterprises
- Reduce over-supply by constant comparison

## VI. CONCLUSIONS

A smart city uses digital technologies or information and communication technologies (ICT) to enhance quality and performance of urban services to make lives of citizens better. 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.

## VII. VII.ACKNOWLEDGEMENT

This work was been carried out as part of the project ID_34_462, SMIS 2014+ from Programul Operațional Competitivitate 2014- 2020 Axa prioritară 1 – Crearea de laboratoare privind cercetarea datelor de mari dimensiuni în vederea dezvoltării unor produse inovative și a unor aplicații în domeniul internetul viitorului (Creating research laboratories for BigData in order to develop innovative products and applications in the field of Future Internet).

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