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The Influences of User Generated "Big Data" on Urban Development

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1 ABSTRACT

Cities are the nucleus for creativity and ideas, as it has all the potentials for people to work, explore and live. People always come to cities because they want to be part of something, this magnet in the cities created the problem of population (Ericsson: Thinking Cities in the Networked Society, 2012). Approximately 50% of world's population lives in urban areas, a number which is expected to increase to nearly 60% by 2030. (Mutizwa-Mangiza ND, Arimah B C, Jensen I, Yemeru EA, Kinyanjui MK, 2011).

According to the rapid change in cities' population there exists a need to utilize intelligent prediction tools to deliver a better way of living. Smart cities provide an opportunity to connect people and places using innovative technologies that help in better city planning and management (Khan, Anjum, Soomro, & Tahir, 2015).

Data is never a new thing, but data sources are always in change. The internet made everything easier and more reachable. This wide range of technologies such as IOT (internet of things) and M2M (machine to machine) (Gartner, 2015), is believed to offer a new potential to deliver an analytical framework for urban optimization. The real value of such data is gained by new knowledge acquired by performing data analytics using various data mining, machine learning or statistical methods.

According to this technologically mutated, data comes from weather channels, street security cameras, Facebook, Twitter, sensor networks, in-car devices, location-based smartphone apps, RFID tags, smart meters, among other sources (Hinssen, 2012). This massive amount of information that comes from real-time based tools, made the world in front of a new era of data called 'Big Data'. However, turning an ocean of messy data into knowledge and wisdom is an extremely challenging task.

The proposed paper will discuss the IOT developed frameworks which are used to improve cities infrastructure and their vital systems. Analyzing these frameworks will help developing a conceptual proposal of data visualizing software; with the aim of helping urban planners get a better and easier way to comprehend the usage of multi-data sources for city planning and management.

The full control of data is an open challenge, however proposing the fundamental bases of framework with the ability to extend and having an application layer above would be very helpful for urban process shifting. The Egyptian case is our main scope to have a smarter city that provides an opportunity to connect people and places using innovative technologies.

2 INTRODUCTION

It is a matter of fact that technology takes now lion's share of people's concerns. This new enthusiasm about technology, algorithms and applications can give us a better understanding of cities; it also enables stakeholders to have predictive statistics for the decision-making process.

Before going deep in technology, it is important first to simplify the major components of any city. The abstract perspective of any city will lead to the definition of city anatomy by City Protocol. City Protocol promises to put the guidance for cities like what LEED did for buildings (arch daily, 2012), to help us understand and map the interconnections between city systems.

They divided the city into three system elements which form the city ecosystem: (1) the physical structure (structure); (2) the people who live in this physical space (society); and (3) the interactions between people and their physical structure see Fig.1(ancha, 2015). In this paper, we will focus on the third element investigating how people can communicate with their physical environment.

By virtue of information communication technology (ICT), people have the ability to measure, infer and understand their surrounding environment. Nowadays there are real life urban challenges which need a variety of ICT solutions, with the presence of IOT it becomes easier to have information and communication systems invisibly embedded in the environment around us.

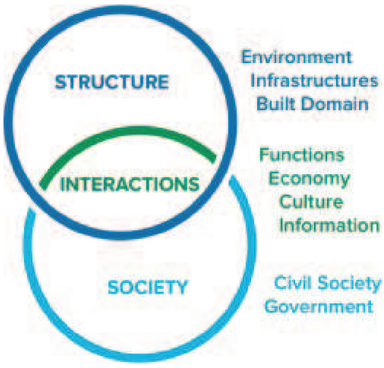

Fig. 1. City Anatomy published by City Protocol Agreement (CPA) (City Protocol)

3 TECHNOLOGIES AND TRENDS

As Gartner's IT Hype Cycle in 2015, the IOT became at the peak of the emerging technologies curve (Fig. 2) (Gartner, 2015). Gartner Hype Cycles provide a graphic representation of the maturity and adoption of technologies and applications, and how they are potentially relevant to solving real business problems and exploiting new opportunities (Gartner Inc.). It has been forecasted the IOT will take from 5-10 years for market adoption.

Fig. 2 Gartner Hype Cycle of emerging technologies. (Gartner, 2015)

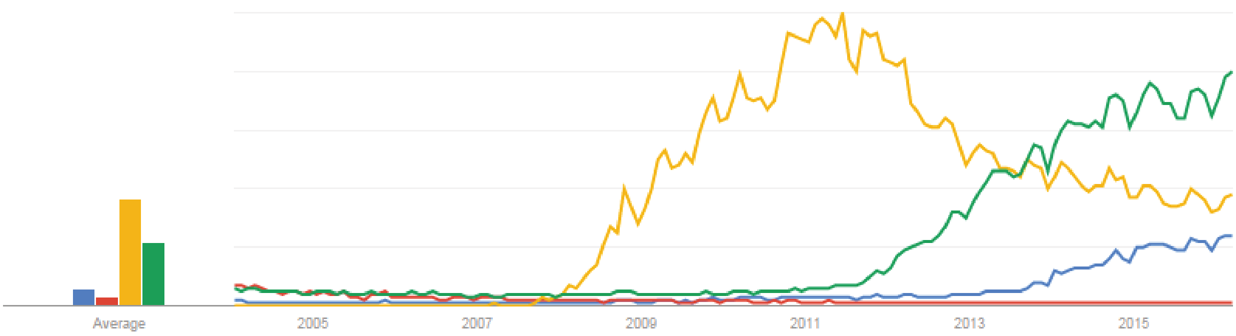

Fig. 3 Google search trends since 2005 for terms Ubiquitous computing, Internet of things, Cloud Computing and Big data.

The popularity of different technologies varies with time. Based on Google search trends measurements this is the web search popularity comparison between ubiquitous computing, Internet of things, Cloud computing and Big data; during the last 10 years shown in Fig. 3 (Google Trends, 2016).

3.1 Ubiquitous computing

ubiquitous computing (ubicomp) is an exciting paradigm that promises to provide computing and communication services to the end users all the time and everywhere; it's objective to embed technology into the background of the daily life (Gubbi , Buyya, Marusic, & Palaniswami , 2013).

Caceres and Friday (2012) discussed the opportunities and the challenges that are facing the ubicomp, they highlighted the two critical technologies that enable the growing of the ubicomp infrastructure (cloud computing and the IOT).

3.2 IOT

From a high level perspective there are three major components for the IOT that enable seamless ubicomp: (1) Hardware such as sensors, actuators and embedded communication devices; (2) Middleware for the purpose of storage, computing and data analytics; and (3) Presentation tools for visualizing the data (Gubbi , Buyya, Marusic, & Palaniswami , 2013).

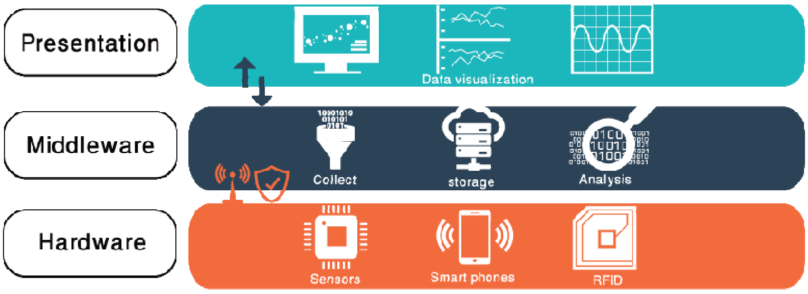

Fig. 4 High-level perspective for IOT architecture.

3.2.1 Hardware

Focusing on sensors, Intel said that "without sensors there is no IOT". There are enormous types of sensors that can measure anything. Briefly, the sensors system architecture: (1) sensors such as: RFID tags, ZigBee, NFC, IBeacon, etc.; (2) processor: to collect the data from sensors; (3) gateway: for accessing the internet; and (4) the data center: the place where data can be stored and analyzed (Hanafy, 2015).

3.2.2 Data storage and analysis

All the generated data from multi sources have to be allocated and stored for the required processing, simulation and visualization tasks. It is important to develop artificial intelligence algorithms for smart monitoring and actuation. Cloud-based storage solutions are increasingly popular to access applications on demand from anywhere (Khan, Ludlow, McClatchey, & Anjum, 2012;Gubbi, Buyya, Marusic, & Palaniswami , 2013).

3.2.3 Data visualization

This layer serves to convert data into knowledge and to present meaningful information from raw data (Gubbi , Buyya, Marusic, & Palaniswami , 2013). Visual analytics is a discipline in visualization science that is resulted from combining the information visualization, scientific visualization and data mining communities all that to provide techniques and tools that support end users to have interactive visual interfaces (Telea, 2007).

3.3 Cloud computing

Cloud computing is a term wherein the capabilities of business applications are exposed as service that can be accessed from anywhere in the world on demand. Thus, the computing world is rapidly transforming to develop software for millions to consume as a service rather than having it on their individual computer and that is the meaning when referring to an infrastructure as "Cloud" (Buyya, Yeo, Venugopal, Broberg, & Brandic, 2008).

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Cloud providers offer some services that can be grouped into three categories: (1) Infrastructure as a service (IAAS), where the providers offer the consumer processing, storage, networks, and other fundamental computing resources; (2) Platform as a service (PAAS), where the providers offer the consumer programming languages, libraries, services, and tools; and (3) Software as a service (SAAS), where the consumer can use the provider’s applications running on a cloud infrastructure which can be accessed through various devices (Fig. 5) (Mell & Grance, 2011;TeachMeCloud, 2013).

Fig. 5 Cloud service models.

3.4 Big data

The physical world is now becoming a platform for generating a lot of data “Big data”. Big data is the term referring to the large, complex streams of data generated by ubiquitously sensors and the digitized lifestyle (Rabari & Storper, 2013).

Marr (2015) described “Big Data” technology by the following five “V”s: (1) Volume: referring to the huge amount of data generated every second; (2) Velocity: referring to the speed of generating new data; (3) Variety: which refers to the different types of data; (4) Veracity: referring to the trustworthiness of data; and (5) Value: referring to the ability of turning this data into value.

4 CASE STUDIES

Many cities are currently trying to involve technology in their vital systems. Thus, there are various initiatives from all the leading companies to come-up with a matured platform for cities to use. The presented case studies will focus on cities that use IOT and technologies to deliver a better way of living and smart urbanism for their inhabitants and visitors.

4.1 Amsterdam Smart City.

Project description:

“The Amsterdam Smart City (ASC) Public-Private-People-Partnership is a unique partnership between companies, governments, knowledge institutions and the people of Amsterdam” , it is a community-oriented initiative through an open platform toward addressing city challenges (Vermast, 2015). It uses the 4P collaboration (Public-Private-People-Partnerships) which is supported by the European Network of Living Labs (ENOLL) (Cohen, 2014). This project has applications that cover the main aspects of any smart city: smart mobility, smart living, smart society, smart areas, smart economy, Big and open data, infrastructure and living labs; underneath every category there are many projects and implementations.

4.1.1 <u>iBeacone Living Lab:</u>

Becones are a low-cost hardware, they use a low-energy Bluetooth connections to transmit messages or prompt directly to smartphones or tablets (Danova, 2014). “Beacons give objects a personality” As described by the Amsterdam smart city (Smart Areas, 2015), Beacons make every object talk about itself, for example, the doorway could say welcome to you. They can tell you the nearest coffee shop that offers coffee with half price, even if you are a tourist they can explain themselves in your language. Beacons are a great way for developing apps engaging IOT. The city of Amsterdam is running this project through 2015 and 2016 under the smart area category to create a series of installations that enable inventors to test their products, prototypes, and ideas. The project will provide a route of up to 2 Km with beacons lining it for inventors to test their applications, which cover:

- public wayfinding,
- tourist routes,
- iBeacon signing,
- Hyperlocal point of interest,
- Augmenting existing apps with additional proximity data.

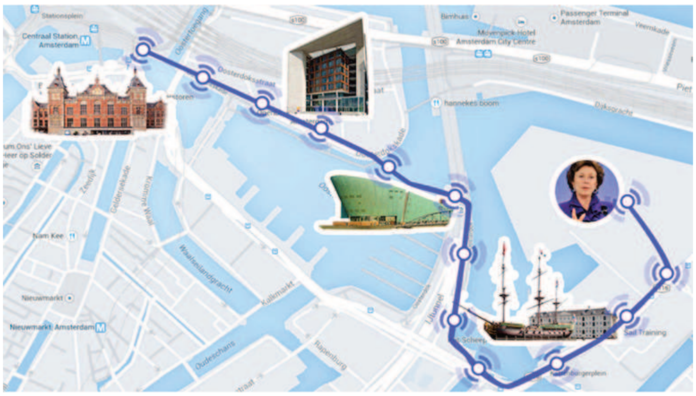

Fig. 6 A route of 2 Km with beacons lining it (Amsterdam smart city: Smart Areas, 2015).

4.1.2 Smart CitySDK

"CitySDK is a service development kit for cities and developers, it aims at harmonizing application programming interfaces (APIs) across cities". It is an open source project for cities to use, since January 2012, eight European cities have worked together to create some reusable interfaces and processes.

During the development of the CitySDK the concentration was on participation, mobility and tourism and the result was these three APIs (application program interface): Open 311 API, Linked Data API and Tourism API (What is CitySDK?, 2016).

Amsterdam has implemented the Linked Data API, which makes city services easier to implement, data easier to distribute, and applications easier to build, and works for both real-time and static datasets (Waag Society, 2016). It collects open data of governments in order to provide several data sets and connect them to the open street map as shown in Fig. 7.

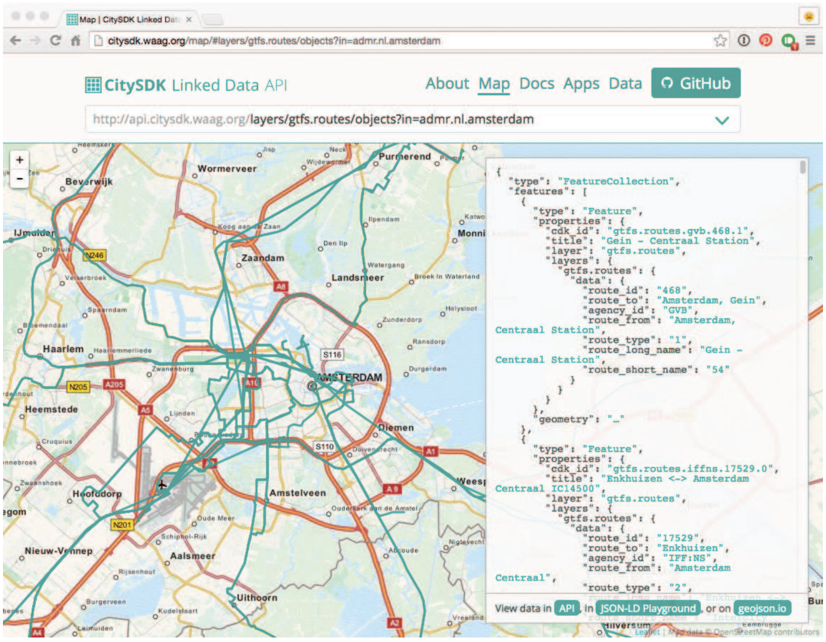

Fig. 7 CitySDK Linked Data API implementation on Amsterdam (WaagSociety, 2015).

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The Waag society was responsible for the mobility domain. One of the Waag society developers Bert Spaan has made a map within the framework of European smart citySDK; showing the age of Dutch buildings. The project was to show all 9,866,539 buildings in The Netherlands, shaded according to their year of construction (Fig. 8), whether they are still relatively young (in blue, built after 1960) or very old (in red). This project gave Amsterdam a completely new image about their country and clearly shows the age of cities. For example, a city like Haarlem of which the old inner city clearly lights up, or Almere covered in blues as it is built in recent times (Waag Society, 2013).

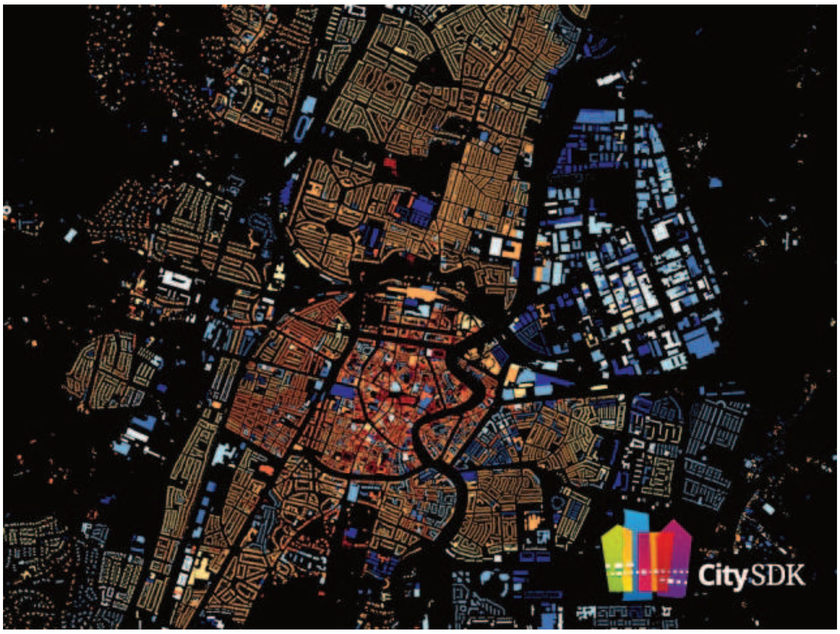

Fig. 8 Map shows the age of Dutch buildings (Waag Society, 2013).

4.2 New York City24/7.

Project description:

The aim of the project was making the public communication more accessible to everyone, everywhere. In collaboration with Cisco IBSG and the city of New York, “an interactive platform that integrates information from open government programs, local businesses, and citizens to provide meaningful and powerful knowledge anytime, anywhere, on any device” was launched. Smart screens were located at bus stops, train stations, major entryways, shopping malls, and sports facilities (Fig. 9) to deliver the information people need to know, where and when it helps them the most (Mitchell, Villa, Stewart-Weeks, & Lange, 2013).

Fig. 9 City24/7 Smart Screen Locations (Mitchell, Villa, Stewart-Weeks, & Lange, 2013).

City 24/7 smart screens combined touch and voice technology to deliver a wide range of information and services in real-time to all citizens with different languages as well as supporting people with disabilities. The smart screens include: a headphones jack for the hearing-impaired, a high contrast mode for the sight-impaired, visual recognition for people with guide dogs, way-finder key-fob access and mobile applications for the blind and a patent-pending flip screen for people in wheelchairs (Frazier & Touchet, 2012).

Inform, Protect, Revitalize were the main goals of the City 24/7 project, the smart screens benefits citizens and visitors, city governments and business (Frazier & Touchet, 2012).

- Inform people interact with City 24/7 screens to have full information about what they want. For local residents "they can view real-time neighborhood news, explore local events and programs, find reviews of nearby restaurants and bars, and receive offers and promotions from merchants within walking distance". For visitors, the smart screens provide them with attractions, discounts at a local hotspot and make suggestions about their travel plans.
- Protect the smart screens play an important role in the safety and security of people in their surrounding area. City 24/7 smart screens offer the police and fire department a citywide sensing, communication and response network that can direct needed personnel and resources to the right place. They also have sensors that predict dangerous chemical, biohazard, and environmental conditions before they do harm and enable the public officials to alert people about this disasters.
- Revitalize by helping citizens and visitors and provide them with the needed information and protect them, cities are more likely to improve their levels of commerce, investment, and tourism. City 24/7 smart screens create a new connection between advertisers and the local shoppers, "For example, ads offered on the Smart Screens or delivered to nearby smartphones and tablets can be tailored to local conditions, including the time of day (e.g., a coupon for free entry to happy hour at the corner club), weather (e.g., a discount on a cup of coffee when temperatures fall below 50 degrees), and even ambient light (e.g., a promotion for sunscreen at the local convenience store when the UV index reaches dangerous levels) ".

4.3 Barcelona

Project description:

Barcelona has emerged as one of the global leaders in the smart cities movement. In launching its IOT program, it had a solid foundation of the network made of fiber optic cable within the city. This network provides now 90 percent of the home coverage and serves as a backbone for all the city systems (Adler, 2016).

Barcelona used this fiber network to build out individual IOT systems across the urban context. In transportation, Barcelona has implemented a sensor system that guides the drivers to the available parking spaces. The sensors were embedded in the asphalt, they can sense whether or not a vehicle is parked in a given location. By directing drivers to open spaces, the program has decreased congestion and emissions (Fig. 10) (Adler, 2016).

ApparkB is the application that is used by the drivers to find parking lots, it enables them to pay for parking online. After a year of implementation, the city was issuing 4,000 parink tickets per day through the application (Adler, 2016).

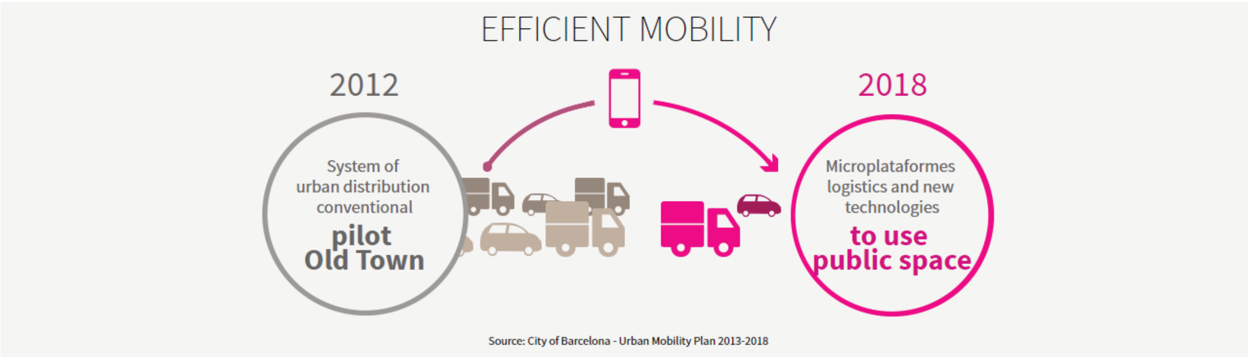

Fig. 10 The Efficient Mobility model by Barcelona (Efficient mobility, 2016).

5 APPLICATION

5.1 Trend

5.1.1 Open Government Data

Nowadays, there is a global movement called the "Open Government Data", it came from Open Data methodology which is described as "being the data that can be freely used, re-used and redistributed by anyone - subject only, at most, to the requirement to attribute and sharealike" (Open Data Handbook, 2016). Governments started to share their data with citizens mainly for three reasons: transparency, releasing social and commercial value and participatory governance (Open Knowledge, 2016), (Open Government Data, 2016).

5.1.2 IOT Applications

Potential applications of the IOT are numerous and diverse, interfering into all areas of everyday life of individuals, communities and industries. The IERC has identified the domains of the IOT applications as follow: smart energy, smart health, smart buildings, smart transport, smart industry and smart city (Fig. 11) (Vermesan & Friess, 2014).

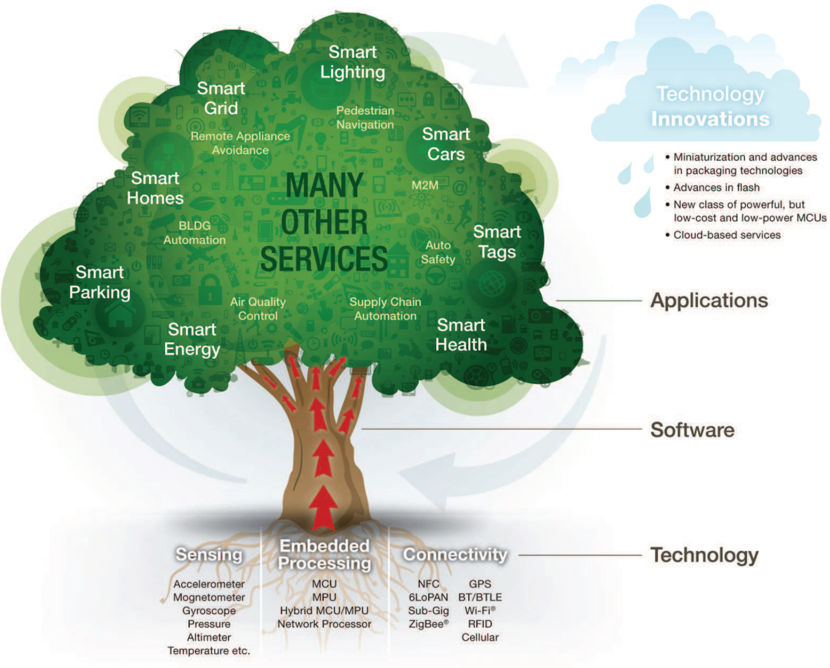

Fig. 11 the IOT: different services, technologies, meanings for everyone (Vermesan & Friess, 2014).

Libelium Company (2016) has created 50 sensor applications for smarter world. In the smart cities domain they created this applications: smart parking, structural health, noise urban maps, smartphone detection, electromagnetic field levels, traffic congestion, smart lighting, waste management and smart roads.

5.2 Egypt "Open Government Data" Model

Egypt followed this trend, it has a data portal at "Open Data For Africa". Providing data about the following categories: Demographics, Marital Status, Disability, Egyptian Internal Migration, Education, Health, Population by Economic Activity, Households, Employment and Living conditions (http://egypt.opendataforafrica.org/).

It has another open data initiative to improve citizen involvement, participation and to make it possible for users to analyze and create value from public sector information

(http://www.egypt.gov.eg/english/general/Open_Gov_Data_Initiative.aspx).

5.3 Project description

There exists plenty of data to be used, which created the Big Data in the first place. Our main challenge is putting this data in its right place, and getting the maximum benefits from them. By following Amsterdam model in consuming the government data in the Smart CitySDK project, one will have a map with datasets (static- real-time). The static part would be from the Open Government Data and the real-time part would be from sensors, RFID tags, smartphones signals, tweets, etc.

5.4 Application Architecture

The application architecture will be as portrayed in Fig. 12. It is a bottom-up approach that depends on the data provided by the government, and which will be combined with the real-time data generated from sensors. This application will help the vital systems of the city by visualizing the given data for better city management.

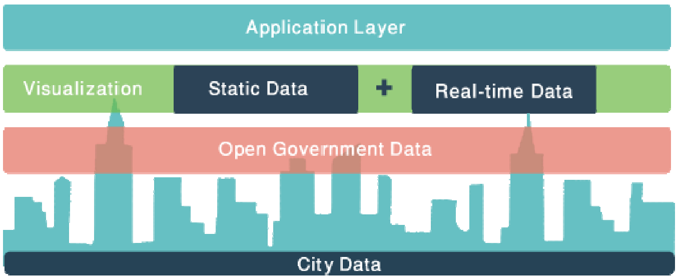

Fig. 12 Application Architecture.

5.5 Prototype demo

If cities stockholders want to determine the energy consumption at a specific sector of a city and they want to combine this data with the population in the same area to calculate the consumption rate, then using this application will offer a great help.

The application consists of three main menus: (1) the main menu; (2) the viewing window; and (3) the data selection window.

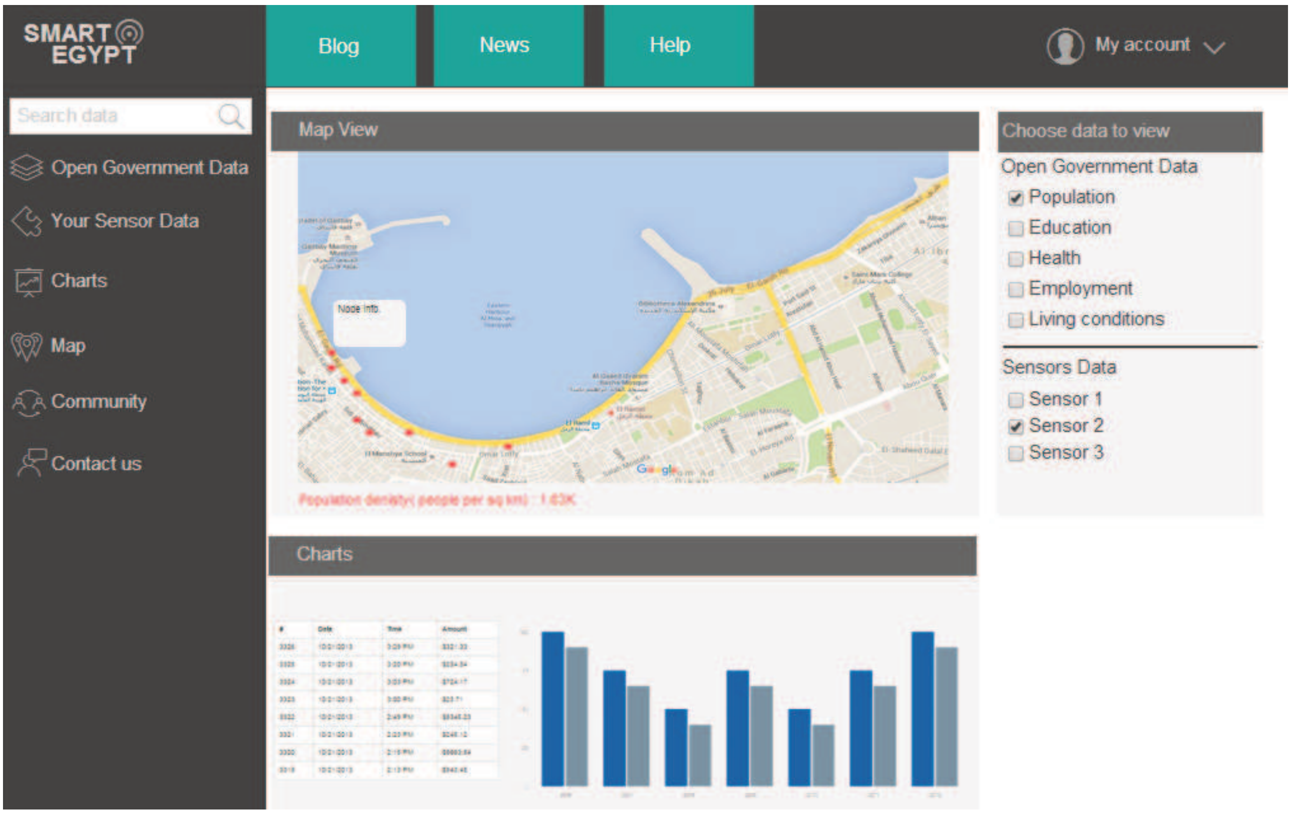

Fig. 13 Application prototype.

6 REFERENCES

1) Hanafy, M. (2015). Internet of things (IOT). Presentation, Information Technology Institute, Alexandria, Egypt.

ISBN 978-3-9504173-0-2 (CD), 978-3-9504173-1-9 (print)
Editors: Manfred SCHRENK, Vasily V. POPOVICH, Peter ZEILE, Pietro ELISEI, Clemens BEYER

2) (n.d.). Retrieved March 29, 2016, from Open Data Handbook: http://opendatahandbook.org/guide/en/what-is-open-data/
3) (n.d.). Retrieved March 29, 2016, from Open Government Data: http://opengovernmentdata.org/
4) (n.d.). Retrieved March 29, 2016, from Open Knowledge: https://okfn.org/opendata/
5) Frazier, J., & Touchet, T. (2012). Transforming the City of New York: New Platform for Public-Private Cooperation Ushers in Smart Cities of the Future. Cisco.
6) Khan, Z., Anjum, A., Soomro, K., & Tahir, M. A. (2015). Towards cloud based big data analytics for smart future cities. Journal of Cloud Computing.
7) Mell, P., & Grance, T. (2011). The NIST Definition of Cloud Computing. National Institute of Standards and Technology.
8) Mitchell, S., Villa, N., Stewart-Weeks, M., & Lange, A. (2013). The Internet of Everything for Cities: Connecting People, Process, Data, and Things To Improve the 'Livability' of Cities and Communities. Cisco.
9) Rabari, C., & Storper, M. (2013). The Digital Skin of Cities: Urban Theory and Research in the Age of the Sensored and Metered City, Ubiquitous Computing, and Big Data.
10) Adler, L. (2016, February 18). How Smart City Barcelona Brought the Internet of Things to Life. Retrieved from Data Smart City Solutions: http://datasmart.ash.harvard.edu/news/article/how-smart-city-barcelona-brought-the-internet-of-things-to-life-789
11) Amsterdam smart city: Big and Open data. (n.d.). Retrieved from http://amsterdamsmartcity.com/projects/detail/id/68/slug/smart-citysdk
12) Amsterdam smart city: Smart Areas. (2015). Retrieved from Amsterdam smart city: http://amsterdamsmartcity.com/projects/detail/id/104/label/ibeacon-living-lab
13) ancha, T. . (2015). City Anatomy:A Framework to support City Governance, Evaluation and Transformation. City Protocol Agreement (CPA).
14) arch daily. (2012, December 3). City Protocol to Set Standards for Smart Cities. Retrieved from http://www.archdaily.com/299352/city-protocol-to-set-standards-for-smart-cities
15) Buyya, R., Yeo, S. C., Venugopal, S., Broberg, J., & Brandic, I. (2008). Cloud computing and emerging IT platforms: Vision, hype, and reality for delivering computing as the 5th utility. Elsevier.
16) Cáceres, R., & Friday, A. (2012). Ubicomp systems at 20: Progress, opportunities and Challenges. the IEEE CS.
17) City Protocol. (n.d.). Retrieved from http://www.cptf.cityprotocol.org/ancha
18) Cohen, B. (2014, May 27). Leading Smart Cities Promote 5P Collaboration. Retrieved from UBM'S Future Cities : http://www.ubmfuturecities.com/author.asp?section_id=219&doc_id=526721&
19) Danova, T. (2014, October 23). BEACONS: What They Are, How They Work, And Why Apple's iBeacon Technology Is Ahead Of The Pack. Retrieved from Business Insider : http://www.businessinsider.com/beacons-and-ibeacons-create-a-new-market-2013-12
20) Efficient mobility. (n.d.). Retrieved March 29, 2016, from http://mobilitat.ajuntament.barcelona.cat/ca/pla-de-mobilitat-urbana/mobilitat-eficient
21) Ericsson: Thinking Cities in the Networked Society (2012). [Motion Picture].
22) Gartner. (2015). Retrieved from http://www.gartner.com/newsroom/id/3114217
23) Gartner Inc. (n.d.). Retrieved from http://www.gartner.com/technology/research/methodologies/hype-cycles.jsp
24) Google Trends. (n.d.). Retrieved March 23, 2016, from https://www.google.com/trends
25) Gubbi , J., Buyya, R., Marusic, S., & Palaniswami , M. (2013). Internet of Things (IoT): A vision, architectural elements, and future directions. ELSEVIER.
26) Hinssen, P. (2012). Open Data Power Smart Cities. Across Technology.
27) Khan, Z., Ludlow, D., McClatchey, R., & Anjum, A. (2012). An architecture for integrated intelligence in urban management using cloud computing. SpringerOpen Journal of cloud computing.
28) Marr, B. (2015, March 19). Retrieved from IBM Big Data and Analytics Hub : http://www.ibmbigdatahub.com/blog/why-only-one-5-vs-big-data-really-matters
29) Mutizwa-Mangiza ND, Arimah B C, Jensen I, Yemeru EA, Kinyanjui MK. (2011). Cities and climate change: Global report on human s ettlements. .
30) Sensors Bring IOT Projects to Life. (n.d.). Retrieved March 30, 2016, from Intel Developer Zone: https://software.intel.com/en-us/iot/hardware/sensors
31) TeachMeCloud. (2013). Retrieved from http://www.teachmecloud.net/introduction.html
32) Telea, A. C. (2007). Data Visualization: Principles and Practice, Second Edition.
33) the Amsterdam Institute for Advanced Metropolitan Solutions. (2014). Retrieved from http://www.ams-institute.org/partners/
34) Top 50 IOT sensor applications ranking. (n.d.). Retrieved March 29, 2016, from Libelium: http://www.libelium.com/top_50_iot_sensor_applications_ranking/#show_infographic
35) Vermast, F. A. (2015, August 17). City Project – Amsterdam Smart City. Retrieved from City Protocol : http://cityprotocol.org/protocol/city-project-amsterdam-smart-city/
36) Vermesan, O., & Friess, P. (2014). Internet of Things – From Research and Innovation to Market Deployment.
37) Waag Society . (2013, August 31). Map shows age of Dutch buildings. Retrieved from http://waag.org/en/news/map-shows-age-dutch-buildings
38) Waag Society . (n.d.). CitySDK Linked Data API. Retrieved March 28, 2016, from http://citysdk.waag.org/
39) WaagSociety. (2015). Retrieved from Github: https://github.com/waagsociety/citysdk-ld
40) What is CitySDK? (n.d.). Retrieved March 27, 2016, from http://www.citysdk.eu/about-the-project/