Smart Cities

Abstract

An eight-faceted integrative framework has been proposed by Chourabi, et al for understanding the concept of smart cities and to be used to evaluate the components of smart city initiatives. This paper begins by establishing a historical starting point to cities facing economic and population change. It continues with steps to contextualize smart cities by a brief exploration of papers and publications covering governance. We outline the Chourabi Framework while exploring other proposed models for explaining the smart city concept. The paper takes a selection of cities and explores various smart city initiatives through the lens of the Chourabi Framework to create a viewpoint of how these initiatives match the framework criteria. We conclude by outlining some of the questions posed by this final city initiative examination and how a model could apply to developing future smart city initiatives.

Introduction

Following World War II the United States Director of the Office of Scientific Research and Development, Dr. Vannevar Bush, weary of years of coordinating science with warfare postulated on a conundrum: an enormous increase in information and the resulting struggle to productively access information and use it to improve society [1]. As Bush pondered the role of post war science, America's industrial cities were facing the issue of infrastructures designed to support a nineteenth and twentieth century economy and populations which had exploded to support them [2] . Built on the success of decades of invention, cities set a new course on an economic transformation implementing everything from redevelopment projects to adaptive reuse [3]. Compounding the problem for cities is a well-documented [4],[5],[6] flight to suburban areas and the resulting concept of smart growth[7]. The response from U.S. cities has been

an emphasis on creating diverse and balanced economic activity, and to increase marketability and attractiveness of urban centers. Historically, city populations have ebbed and flowed with the rise and fall of legacy industrial frameworks. Pittsburgh, Pennsylvania is one example of a city where populations nearly doubled, then halved due to changing times [8]. Worldwide, urban populations are exploding. This paper will focus on cities in the U.S. - where 82% of the country's population live in urban areas (fig. 1), and in Europe – where 80% of the population live in urban areas (fig. 2). Worldwide, China and India are projected to add over 600 million persons with a significant trend towards populating in urban centers over the next 30 years [9]. This will increase pressure on city services, economy, environmental conditions and community cultures. The concept of the smart city has evolved emphasizing strategies effecting sustainability, citizen well-being and economic development. Within the fabric of a smart city lie information and communication technologies (ICTs), however, they are just one thread in the system of systems. Any method of examining cities must be integrative and multi-dimensional to appraise across a variety of domains which we will explore throughout this paper. Many smart city frameworks have spawned in recent years, each attempting to apply a model – whether generally or more granularly - to examine what makes a city a smart city. The following section briefly highlights some of the proposed models which can be used to examine smart cities. In a later section, we explore the Chourabi Framework and evaluate and explore initiatives which make up Helsinki, Finland in Europe and Bellevue, Washington and Chicago, Illinois in the United States. We also conclude that the Chourabi Framework would be a way to evaluate smart city initiatives and to create a working guidebook, if you will, of project examples which could be used to design future smart city initiatives around the world.

A Smart City Timeline

This section lays out selected events and literature in chronological order with the aim of walking the reader towards a broad understanding of how the concept of the smart city has evolved (fig.3).

Reinventing Government: Public-Private Partnerships

We begin with *Reinvent-ing Government: How the Entrepreneurial Spirit is Transforming the Public Sector*, by David Osborne and Ted Gaebler. Published in 1992, the book is a watershed moment in that it suggests city governments change their hierarchical, in-house service model of doing business and proposes a new methodology to how governments can do it. The authors suggest a ten principled format for a more service-dominant mindset and delivering high quality services. The list includes suggestions to eliminate command and control, decentralization, preventative planning, earning money in-house, approaching clients as customers, agency review, minimization of rules, injecting competition and incorporating team structure utilizing outside clients [10]. The lynchpin is their proposal for governments to utilize alternatives to in-house program creation and delivery by developing public and private partnerships. The public-private partnership concept, while nothing new, would also be a component of President Bill Clinton's National Performance Review, a well-publicized effort to improve efficiencies in federal government [11]. It's also a concept appearing repeatedly in our examination of models to define the smart city, such as the Triple-Helix [12]. It's the foundation supporting projects such as IntelCities which combine city government and private business to develop e-Government services [13].

Social Capital

Robert D. Putnam's much-discussed 1995 *Journal of Democracy* article "Bowling Alone: America's Declining Social Capital," highlights a percolating dynamic of declining civic engagement between the 1960's and 1990's [14]. Putnam examines affiliations ranging from church-going, labor unions, parent-teacher organizations, the League of Women Voters, Boy Scouts, and Elks clubs, to a whimsical yet pointed observation of the rise of the total number of bowlers in America, how they bowl alone – not in leagues, and his underpinning statistic that 80 million Americans bowled at least once in 1993, nearly a

third more than those who voted in the 1994 congressional elections. While Putnam counters his own argument by noting the rise of participation in groups like the Sierra Club and the American Association of Retired Persons, his argument that civic engagement and social connectedness are eroded within the U.S. resonates. One important facet prevalent in most models of smart cities is that of building social capital. In the smart city context, this might involve living labs, the use of ICT's to allow access, catalyze interaction and apply hypothesis of human capital as a predictor of smart city growth [15], or approaches which leverage ICT's in combination with citizen access to increase sociability of cities [16], [17], [13], [12], [18], [19].

Economic Development

The case of Singapore illustrates the transformation from industrial city of low tech jobs and services to an intelligent – wired, knowledge-based, information economy [19]. Faced with increasing competition from cities who offered similar economies and products, Singapore invested heavily in IT recognizing its transformative potential to impact the way they live. Singapore is one of the first cities to deliberately create governance enabling their technological development. In 1992 their National Computer Board described it in these terms:

> In our vision, some 15 years from now, Singapore, the Intelligent Island, will be among the first countries in the world with an advanced nation-wide information infrastructure. It will interconnect computers in virtually every home, office, school, and factory.

The Information Superhighway Collides With Public Infrastructure

Roller and Waverman examined the investment in telecommunications infrastructure of 21 countries in the world-wide Organization for Economic Co-operation and Development (OECD) over a 20 year period and synthesized numerous economic reports, finding that investment does indeed provide measureable results [20]. One pivotal element which the authors note is missing, is the role of governments in fostering growth and creating competitive economies. As we explore smart city models later in this paper, we begin to see this issue addressed as a key element.

A Creative Class

A widely read and sometimes polarizing view popularized by Richard Florida in his 2002 book, *The Rise of the Creative Class*, is the view of diversity and creativity as *the* fundamental catalyst of economic growth [21]. Criticism is directed at city governments accused of embracing this outlook and who's aim is believed to lie in policy making coupled with marketing their cities to attract young, educated, ethnic minorities, gays and lesbians and developing cultural attractions in order to lure creative workers who "start and staff innovative and fast-growing companies [22]." Florida postulates a creative index, ranking cities from low to high and displaying "economic dynamism," while detractors dismiss what they term a lack of sound economic model and analysis to whether or not a city's economy can prove high performance over time. Whether one agrees or disagrees with Florida's assessments, one thing is certain, cities have indeed strategized livability into their planning initiatives as this paper reviews later when exploring smart city models.

Smart Cities

In 2007, Rudolph Giffinger with Edinburgh Napier University created a smart city ranking of 70 cities within the European Union based on urban characteristics and creating city profiles. Profiles consisted of

six “smart” characteristics: economy, people, governance, mobility, environment and living; and 31 factors distributed within the characteristics using 75 economic statistical indicators to create the final rankings [23]. While separate initiatives, the European Commission has been developing a Smart Cities and Communities Initiative which launched in June, 2011. Their goal is to develop a 20 percent reduction in energy use by 2020 and develop a low carbon economy by 2050 [24].

Robert Hollands explored smart cities in 2008 by identifying what he saw as three problems: the assumptions of smart city as a celebratory label, an opinion that the label is more marketing hype than a practical engine for infrastructural change, and the term itself carrying an uncritical, pro-development stance [25]. Hollands finishes with an endorsement that smart cities planning begin by considering human capital as the most important component.

A Triple-Helix model of smart cities is introduced by Leydesdorff and Deakin in 2011 and emphasizes smart cities as a process of cultural reconstruction underpinned by policy, academic leadership and corporate strategy in their guidance [12]. Simultaneously, the Triple-Helix model frames the relationship between industry, government and academia as reflexive and an overlay which influences how technologies co-evolve.

In 2011, Nam and Pardo introduce a model of Three Dimensions - technology, people, and institutions – by which smart cities strategize. The authors view a smart city as model for improving city services and economic development catalyzed by local governments. Final conclusions highlight a recurring concept found in all smart city models: that of variable social components and their importance within outcomes of smart city planning and their linkage with the technologies which have power to transform economy, environment and community.

Chourabi, et al Integrative Framework

In this section, we briefly explain each facet of the Chourabi Framework, introduced in January, 2012. In the next section we examine smart city initiatives viewed through the Chourabi Framework. To focus precisely how an initiative meets the facets of the Framework, each facet was distilled into a single question. Below, are each facet followed by our distillations.

1. **Policy Context:** Are current local or regional policies facilitating or creating barriers to the initiative?
2. **Management and Organization:** Are inter-organizational and cross-organizational efficiencies in place to facilitate the initiative?
3. **People and Communities:** Does the initiative positively impact the quality of life for citizens and communities?
4. **Technology:** Does the Smart City initiative include or incorporate IT systems that provide real-time awareness and advanced analytics to help people make decisions?
5. **Economy:** Does the initiative promote positive economic outcomes?
6. **Built Infrastructure:** Is an ICT infrastructure in place to support the Smart City initiative?
7. **Governance:** Does the initiative support citizen participation in the governance of the community?
8. **Natural Environment:** Does the Smart City initiative address the burden of population growth?

Smart City Initiatives Examined Within the Integrative Framework

Helsinki: The Economic Advantages of Clustering and Open Data Competitions

Finland is generally considered a Small and Open Economy (SMOPEC) and companies emerging from countries of this size scale face many challenges. Small, technology oriented companies entering the world stage from this environment, sometimes called “Born Globals” must utilize “large channels

provided by multinational corporations, networks, and/or the Internet to receive substantial revenues and cash flow rapidly" [26]. Hielkema & Hongisto [27] describe how clustering has developed in the Helsinki region around mobile application development to take advantage of high-tech economies of scale. These communities of interest become a cauldron of innovation, "allowing competition and collaboration to include actors beyond the regional cluster."

Helsinki is home to two of the world's largest electronics manufacturers, Nokia and Philips Electronics. This regional proximity has fostered a climate of entrepreneurship and innovation around mobile apps, most noticeably the company Rovio (the developer of the Angry Birds game app). The governments of the Helsinki Region are further encouraging this clustering through the use of Living Labs and Open Data Competitions and the region is becoming a magnet for industry and individuals engaged in mobile application development.

Hielkema & Hongisto state that "there is a tradition of Living Lab research in Finland and various types of organizations—Universities, city- or region-owned development agencies, companies, and SMEs have established Living Labs." Basing their activities on the principles of User-Driven Innovation, Living Labs have become sponsors of open-data competitions for mobile applications development, further encouraging clustering.

Helsinki Smart City Initiatives Through the Framework

***Policy Context**: Are current local or regional policies facilitating or creating barriers to the initiative?*

- EU Initiatives set the goals, facilitating the development of European cities' competitiveness by enabling efficient modern infrastructures
- The Finnish Government implements Demand and User-Driven Innovation Policy, an instrument encouraging Living Labs to organize Open Data application competitions to stimulate innovation, ideation, development, and delivery of citizen-centric services
- Regional Governments make Open Data resources available

Management and Organization: *Are inter-organizational and cross-organizational efficiencies in place to facilitate the initiative?*

- Policy initiatives indicated earlier are examples of EU, National, and Regional cooperation
- Cross-municipal collaboration is evidenced by the provision of Open Data resources provided by 10-15 regional governments
- Living Labs themselves are indicative of cross-organizational cooperation
- Thematic competitions indicate shared regional goals
- Helsinki Region is self-recognizing as an Mobile Application Innovation Cluster

People and Communities: *Does the initiative positively impact the quality of life for citizens and communities?*

- Living Labs provide resources and create spaces and opportunities for both cooperative and competitive innovation
- Open Data and innovation competitions (i.e. HSL Open and Apps4Finland) create new stakeholders that gain an investment in open access
- Clustering creates communities of interest that can evolve while exploiting externalities and creating linkages, both regionally and globally
- Helsinki has particular and unique regional advantages with the proximity to Nokia and Philips.

Technology: *Does the Smart City initiative include or incorporate IT systems that provide real-time awareness and advanced analytics to help people make decisions?*

- HSL Open mobile apps incorporate real-time location data into transit scheduling service

Economy: *Does the initiative promote positive economic outcomes?*

- Open Data is a valuable raw material for innovation and entrepreneurship, proving the same and equal access between large corporations, SME's, and individual entrepreneurs
- Mobile Application Clustering creates advantages through both economic agglomeration and competitive innovation

Built Infrastructure: *Is an ICT infrastructure in place to support the Smart City initiative?*

- Access to broadband is a legal right in Finland
- LTE mobile access is available throughout much of the country
- WIFI access is available throughout many parts of Helsinki

Governance: *Does the initiative support citizen participation in the governance of the community?*

- Open Data Competitions and Open Data resource availability exemplify a Public-Private partnership

Natural Environment: *Does the Smart City initiative address the burden of population growth?*

- HSL Open Data competition was based on transportation system data, promoting usage efficiencies and increased ridership
- Apps4Finland competition made environmental data available

Chicago: City as Platform

Shortly after his election in 2011, Chicago Mayor Rahm Emanuel introduced a strategic plan that included a comprehensive and explicit effort to make data available from across all municipal government agencies. The strategic plan states "Chicagoans will be invited to develop their own 'apps' to interpret and use City data in ways that most help the public [28]." To spearhead this effort, Emanuel hired Chicago's first Chief Technology Officer and first Chief Data Officer.

Cities are becoming incredibly rich resources of a very valuable raw material: data. But making data available is only a first step. To make the data truly available and accessible to the most people, application programming interfaces (APIs) must also be provided so that developers can easily and inexpensively manipulate the data. Chicago is doing that. "Developers can hook into the portal and receive a continuously-updated stream of data without manually refreshing their applications each time changes happen in the feed. This changes the City from a static provider of data to a kind of platform for application development. It's a reconceptualization of government not as provider of end user experience (i.e., the app or service itself), but as the provider of the foundation for others to build upon [29]." This idea is called "City as Platform", a term increasingly used as Open Data becomes more widely available in cities around the world. In Chicago, there are currently 271 real-time data sets available with 2 new data sets introduced each week.

Like many cities that provide open data, a number of competitions and "hack-a-thons" have been held to introduce developers to available data sets and to jump-start the City as Platform concept. Apps for Metro Chicago (A4MC), a competition open for 6 months with prize money made available by the MacArthur foundation, saw the development of over 70 apps covering topics from community engagement to sustainability. Says Chicago CTO John Tolva, "The apps were fantastic, but the real

output of A4MC was the community of urbanists and coders that came together to create them. In addition to participating in new form of civic engagement, these folks also form the basis of what could be several new 'civic startups'... … the community really crystalized — an invaluable asset for the city [29]."

A number of applications being developed address a major policy initiative being put forward by the Emanuel Administration: reducing "food deserts" in the Metro Chicago area. Upwards to 400,000 Chicagoans live farther than ½ mile from a reliable source of fresh food [30]. Economic, transit, housing and population density data is being used and analyzed to encourage the development of large food stores (over 2500 sq. ft.) in these areas.

Chicago Smart City Initiatives Through the Framework

***Policy Context**: Are current local or regional policies facilitating or creating barriers to the initiative?*

- Open data initiatives are driven by Chicago Administration Policy

***Management and Organization:** Are inter-organizational and cross-organizational efficiencies in place to facilitate the initiative?*

- City departments are cooperating across jurisdictions to provide data access

***People and Communities:** Does the initiative positively impact the quality of life for citizens and communities?*

- Open Data apps competitions form the basis of new 'civic start-ups'
- Food Desert initiatives are designed to make fresh foods available and affordable across the city

***Technology:** Does the Smart City initiative include or incorporate IT systems that provide real-time awareness and advanced analytics to help people make decisions?*

- Open Data efforts provide API's to ease development efforts
- Food Desert initiatives are utilizing analytics to isolate patterns to facilitate data-driven decision-making

***Economy:** Does the initiative promote positive economic outcomes?*

- Open data is seen as a foundation for new businesses built using open source technologies and agile development methods, creating new "Civic Startups"

***Governance:** Does the initiative support citizen participation in the governance of the community?*

- A major goal behind the release of data is increased transparency in government.

Natural Environment: *Does the Smart City initiative address the burden of population growth?*

- Food Desert initiative promotes both farmers markets and urban farming efforts.

Bellevue: City Policies Drive Smart Development

Home to Expedia.com in its downtown core and Microsoft just miles away in Redmond, with Amazon across the lake in Seattle and Boeing just to the South in Renton, Bellevue Washington finds itself at the center of an innovative, high-tech region. Bellevue has developed as a technology-driven city at the same time. The city offers free WIFI throughout the downtown core [31]. They've been an innovator in Intelligent Transportations Systems, being the first city in Washington to install an adaptive traffic system (SCATS) that continually adjusts traffic signaling to adapt to real-time traffic loads and patterns [32] Additionally, the city has installed a Traffic Signal Priority system that gives special treatment to high-capacity transit vehicles at signalized intersections [33]. Bellevue is a member and participant in the eCityGov Alliance, a multi-jurisdictional building permit portal system [34], the first of its kind in the nation [35].

The city has also been engaged in a long-term project being proposed along a new light-rail transit line that will run from downtown Bellevue to Redmond, Washington, travelling along a new corridor parallel to the Bellevue-Redmond Road [36]. Known as the Bel-Red Project, this 900 acre re-development is intended to revitalize an area that has been in decline for some time. Currently a vast area of distribution warehouses, light industrial businesses, and scattered retail, the Bel-Red project will focus on high-density housing and high-tech industry centered around three proposed transit hubs. The area is also slated for day-lighting and restoration of two large fresh water streams that are salmon habitat flowing into Lake Washington.

Bellevue Smart City Initiatives Through the Framework

***Policy Context**: Are current local or regional policies facilitating or creating barriers to the initiative?*

- Each of the projects outlined above are policy initiatives funded or designed by city government

***Management and Organization:** Are inter-organizational and cross-organizational efficiencies in place to facilitate the initiative?*

- The Bel-Red project is a major capital improvement effort that requires cooperation and coordination across multiple agencies and jurisdictions
- The eCityGov alliance is a regional, cross-jurisdictional cooperative effort involving 16 cities

***People and Communities:** Does the initiative positively impact the quality of life for citizens and communities?*

- The Bel-Red project will be a magnet for new development, attractive high-density living spaces and retail on a high-capacity light-rail transit corridor

***Technology:** Does the Smart City initiative include or incorporate IT systems that provide real-time awareness and advanced analytics to help people make decisions?*

- The Intelligent Transportation Systems utilize real-time analytics that manage traffic flow while incorporating high-capacity transit priority.

***Economy:** Does the initiative promote positive economic outcomes?*

- City provides free access to WIFI in downtown core
- The Bel-Red project will promote a tech cluster between downtown Bellevue and Microsoft while revitalizing an area on the downswing
- eCityGov EGov permit portal creates economic efficiencies

***Built Infrastructure:** Is an ICT infrastructure in place to support the Smart City initiative?*

- Muni WIFI: Provides more ICT Infrastructure
- The Bel-Red Project is a major capital improvement project that incorporates mass-transit, fiber ICTs, housing, retail, and industry
- The Intelligent Transportation System involves major transit and traffic arterial infrastructure Improvements

***Natural Environment:** Does the Smart City initiative address the burden of population growth?*

- The Bel-Red Project utilizes Transfer of Development Rights agreements where developers can purchase development rights from rural private properties in exchange for urban density easements
- Daylighting and rehab of two major fresh water watersheds, restoring salmon habitat

Concluding Remarks

Can cities be Smart, or do they just implement a series of Smart initiatives (and what's the difference)?

This paper has introduced the concept of smart cities by examining the decline and restructuring of the industrial city in an effort to establish a reference point to how cities have begun to rethink their economic models. We progressed through touchstone events and publications to establish a timeline for the smart cities concept. Focusing on the Integrative Framework by Chourabi, et al – referred to here for simplicity as the *Chourabi Framework* – we focused on a granular model with which we examined planning initiatives of Helsinki, Finland, Chicago, Illinois and Bellevue, Washington. We established that any model which attempts to define a city as smart will only be effective if it is integrative and multi-dimensional across domains. Several models are highlighted. While high-level models with fewer facets are simpler at first glance, they require much more explanation to understand, while a more granular model like Chourabi Framework, contains greater detail simply by the greater number of facets provided. It has allowed for a more comprehensive examination of initiatives to establish each as smart.

Two key questions arise from our examination. Would an initiative need to address all eight facets of the Chourabi framework to be considered smart? And, how many initiatives that meet smart city qualifications would it take in order for a city to be considered smart? The very nature of our examination begs the question: What next? At minimum, one of the most intriguing aspects of smart city initiatives and any effort to evaluate them is in constructing projects which yield successful blueprints that other cities can use to model their own smart, efficient initiatives. As urban populations continue to rise there will be a need for emerging new cities to quickly build infrastructures and develop integrative initiatives between governments, businesses, communities which are sustainable. Having models to evaluate the effectiveness and efficiency of initiatives will be critical. As older cities legacy

infrastructures are stressed further, leaders in government and business will look to successful models to retrofit and regenerate services, improve marketability, economy, environment and community.

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Appendix

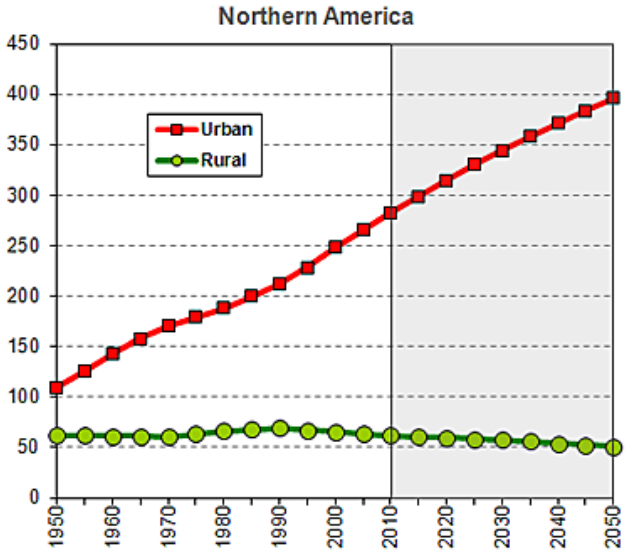


Figure 1

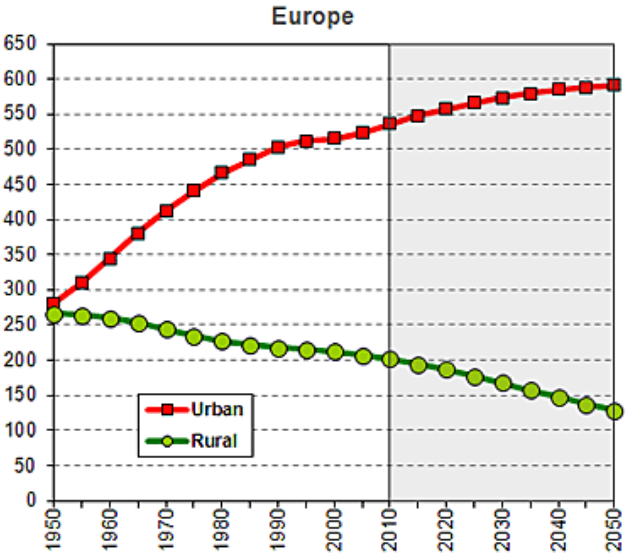
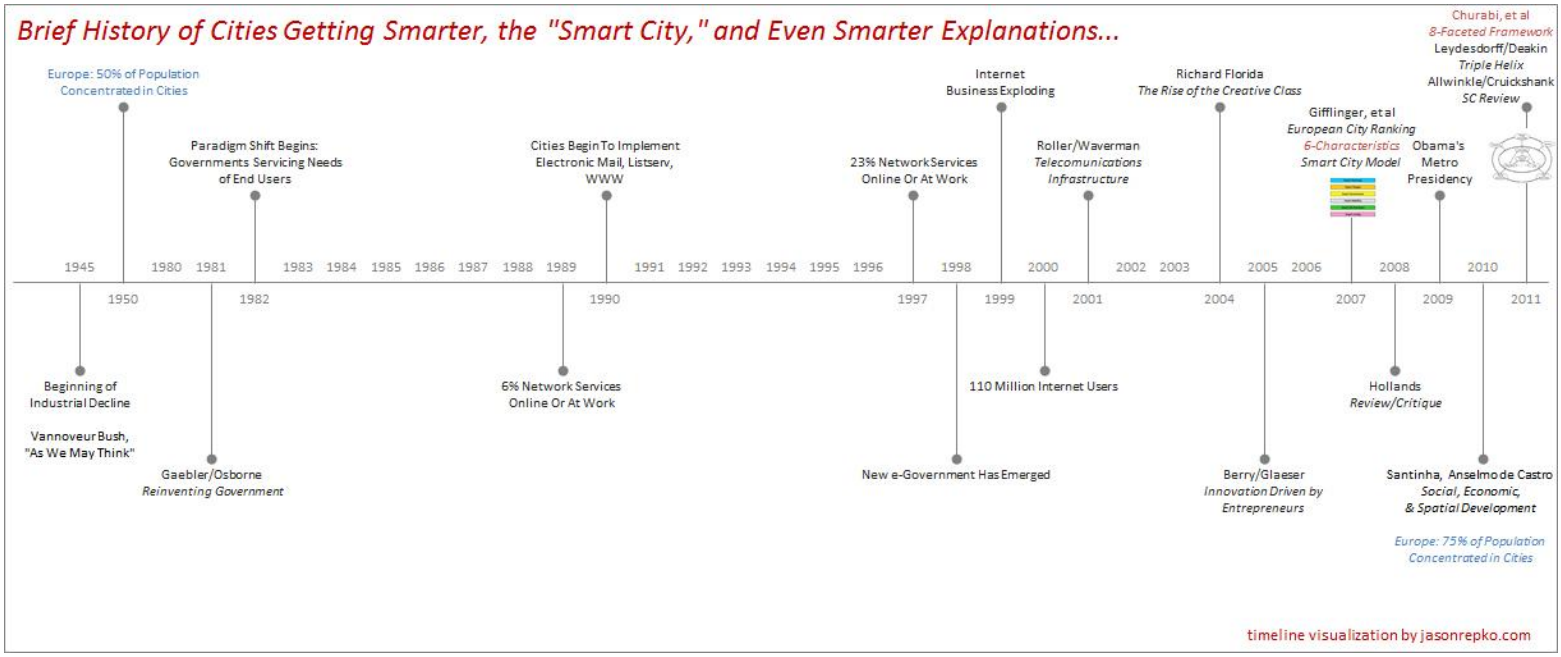


Figure 2

Source: United Nations, Department of Economic and Social Affairs, Population Division: *World Urbanization Prospects, the 2011 Revision*. New York, 2012

Figure 3


Brief History of Cities Getting Smarter, the "Smart City," and Even Smarter Explanations...
Churabi, et al
8-Faceted Framework
Leydesdorff/Deakin
Triple Helix
Allwinkle/Cruickshank
SC Review
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Cities Begin To Implement Electronic Mail, Listserv, WWW
23% Network Services Online Or At Work
Roller/Waverman
Telecomunications Infrastructure
1945
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2011
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Reinventing Government
6% Network Services Online Or At Work
110 Million Internet Users
New e-Government Has Emerged
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timeline visualization by jasonrepko.com