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The Four-Foci Taxonomy for Smart City Design: Towards a Conceptual Framework

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Abstract: Complex socio-political, economic, and environmental challenges have increased the demand for more effective data management and information access. The notion of a smart city has recently evolved to mean a city that is well-endowed by information and communication technologies that complement the physical infrastructure, enhancing the city's social and environmental assets. A city may be defined as "smart" or "intelligent" when investments in human capital, social capital, transportation, and communication infrastructure drive sustainable physical and economic development. Through participatory governance, managed growth should result in a high quality of life and wise natural resource management. Several models for designing a smart city exist, and after analyzing various studies, these models were grouped according to their foci: (1) technological, (2) business, (3) political, and (4) environmental. While the proposed models each have strengths, each model shares four key limitations: (1) limited integration of the local system and global system, (2) scant attention to holistic sustainability, (3) minimal consideration of human factors and human-environment interaction, and (4) inability to address significant urban changes. Takeda's (1990) four-phase research approach was adopted for this research project, the four phases being Phase I (Awareness), Phase II (Suggestion), Phase III (Development), and Phase IV (Evaluation). The research was conducted in several studies. This paper reports on Study 1, which followed a two-phase exploratory and conceptual approach (Phases I & II), in which an in-depth analysis of several smart city case studies reported in the literature was performed. The purpose was to examine promising smart city

models, and critique their effectiveness. Using a literature review, the authors solidified their understanding of smart city design. A taxonomy of key categories of concern when designing a smart city, called the Four-Foci Taxonomy, is proposed in the paper.

Keywords: smart city; conceptual framework; participatory governance; holistic sustainability; human-environment interaction; human factors; shrinking cities; taxonomy.

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1. Introduction

In this paper we suggest that contemporary smart city models, despite their noteworthy contributions to the field of smart city research, deal mainly with limited foci, fail to sufficiently address significant contemporary urban challenges facing many cities, lack a holistic and integrated approach to city development, and neglect human factors. More specifically we suggest that in contemporary smart city models, there is (1) a lack of integration of local systems and regional systems, (2) a lack of attention to holistic sustainability, (3) a lack of consideration of human factors and human-environment interactions, and (4) a lack of ability to address significant urban changes. To address these challenges, we propose that an ideal smart city model should be able to address and overcome (a) a major recession like the current one ("Great Recession") and any significant future recession, (b) public health crises, and (c) a shrinking city phenomenon as well as substantial urban growth challenges. Finally we suggest ways in which these significant challenges may be handled by drawing lessons from contemporary smart city models and several popular urbanisms or urban paradigms. We also suggest areas of further research in the field of the smart city.

Study 1 of this research project is theoretical in nature as we use a conceptual approach to analyzing the current smart city models, and to proposing broad recommendations as to how to improve the existing models. We do this by building on their strengths and accomplishments, and the opportunities they create.

The main research phases are I. Awareness, II. Suggestion, III. Development and Evaluation, and IV. Conclusion (Takeda et. al., 1990).

To support our positions and recommendations, we conducted Phase I and Phase II in the following way.

Phase I. Awareness

- First, through an in-depth literature review, we reviewed and analyzed published case studies, and selected several smart city models that are frequently mentioned in the current literature, according to the outcomes of the case studies.
- We then performed a comparative analysis of the selected smart city models, according to key issues that they address, the primary goals of the models, and the key strategies used to fulfill their goals. During the comparative analysis, we paid particular attention to frequently occurring themes or patterns. As a result, we were able to identify four focus areas in which similar types of smart city models can be grouped together.

Phase II. Suggestion

- Definition. In this phase we defined each of the four focus areas to which a group of smart city models belongs. We also discuss several important aspects and key characteristics of each focus area.
- Findings. Based on the outcomes of the comparative assessment of the four groups of smart city models, we have identified areas that need additional attention as well as key challenges that face each of the four groups of smart city models.
- Recommendations. The results of the comparative assessment form the foundation for our recommendations. We suggest ways to improve the current smart city models, building on what has been accomplished already. We also touch on the areas of further study in the future.

2. Results and Discussion

2.1. Analysis of Smart City Models

Main Through an in-depth literature review, we identified several smart city models that currently exist in the literature. These models are chosen primarily because of the frequency with which they are mentioned in the literature, and we analyzed them according to several variables so the models can be compared (see Table 1). Three general groups of data were chosen to establish baseline information as well as the general characteristics (features) of all models selected for this study: (i) key issues that contemporary smart city models address; (ii) goals of the models; and (iii) strategies that the models employ in order to accomplish the smart city goals. Following is an analysis and comparison of several popular smart city models according to several key focal areas.

Table 1. Table 1: Comparison of Smart City Model Groups by Key Areas. Source: (Authors 2013)

Part 1

Key Features	**Categories of Focal Area**							
	Smart City Model Group 1 Technological focus		**Smart City Model Group 2 Business focus**		**Smart City Model Group 3 Political focus**		**Smart City Model Group 4 Environmental focus**	
Smart city defined, aspiration, common threads	▪ City as a showcase of technological advancements ▪ City that promotes technological advancements ▪ Focuses more on smart city than smart citizens		▪ City as a profit-making, economically sound entity ▪ City that is able to compete in a global market ▪ City as a small nation with autonomy, self-reliance ▪ Focuses on experts and smart people (smart leaders)		▪ City that promotes a civil and participatory society and reasonable behaviors of citizens ▪ Argues that smart citizens lead to smart cities		▪ City that is sustainable, able to cope with climate change, energy crisis, etc. ▪ Smart city as the key player to promote regional sustainability ▪ Requires smart city, smart region, and smart people	
Key proponents, key players	▪ Technocrats	a	▪ Managers	b	▪ Facilitators ▪ Conveners	c c	▪ Regionalists ▪ Environmentalists	d d
Examples of smart city models, primary locations	▪ Models that are based in Asia, especially Far East; led primarily by governments (e.g., Singapore, Japan, Korea, China, Taiwan)		▪ Advanced countries ▪ Rapidly developing countries		▪ North America ▪ Western Europe		▪ North America ▪ Western Europe	

(a) technological; (b) business; (c) political; (d) environmental

Part 2

Key problems that the models are addressing	▪ Deteriorating, outdated urban infrastructure and city services, especially in old and shrinking cities ▪ Lack of coordination among various divisions and jurisdictions in municipal entities	a a	▪ Loss of manufacturing industries/jobs ▪ Population loss ▪ Shrinking city phenomenon ▪ Ongoing "Great Recession" and future recessions ▪ Chronic unemployment in underserved areas ▪ Income disparity	d d d b b b	▪ Lack of interest or participation by citizen in city affairs	c	▪ Shrinking city phenomenon ▪ Extensive vacant land ▪ Declining population, manufacturing industries and jobs ▪ Deteriorating building stocks and traditional urban neighborhoods ▪ Climate change	d d d d d
Key goals of model	▪ Efficiency ▪ Ubiquity of technology ▪ Participation in a global society via technologies ▪ Effective information management system ▪ Keep citizens informed and make them smart via technologies ▪ Civic engagement via user friendly technologies, digital networks	ab a ac ab ac ac	▪ Economic viability ▪ Competitiveness in global economy ▪ Profitability ▪ Efficient information management ▪ Sustainability ▪ Rightsizing cities	b b b bd d d	▪ Civic engagement ▪ Participatory democracy ▪ Collaboration ▪ Sense of community ▪ Social interaction ▪ Building social capital ▪ Informed, active citizens as smart citizens	c c c c c c c	▪ Smart growth ▪ Sustainability ▪ Regionalism ▪ Public health ▪ Rightsizing cities ▪ Responsiveness to energy crisis and climate change	d d d d d d
Key strategies to promote goals	▪ Smart technologies ▪ Experts, smart people ▪ Easy access to Internet ▪ Open source system / open source urbanism ▪ Social media, digital networks	a a a a a	▪ Training of city officials as effective, smart business managers ▪ Branding ▪ Marketing ▪ Creating investment opportunities ▪ International trades with cities around the world ▪ Use of art and design, creative application of art and design in business	b b b b b abd	▪ Social media, digital networks	c	▪ Sustainable urban design ▪ Ecological urban design ▪ Landscape urbanism	d d d

(a) technological; (b) business; (c) political; (d) environmental

Part 3

Limitations, challenges	▪ Digital divide ▪ Coordination among different jurisdictions or agencies ▪ Updating technologies ▪ Lack of skilled labor or skilled workforces that can use technologies efficiently and effectively ▪ Lack of regional collaboration ▪ Limited sustainability, lack of attention to sustainability	ac abc a ab d d	▪ Social equity ▪ Distribution of wealth ▪ Coordination among different jurisdictions or agencies ▪ Lack of regional collaboration ▪ Limited sustainability, lack of attention to sustainability	b b abc d d	▪ Low level of participation by low income people ▪ Equal representation of diverse communities and groups ▪ Lack of regional collaboration ▪ Limited sustainability, lack of attention to sustainability	c c d d	▪ Suburbanization ▪ Lack of efficient public transit system ▪ Lack of regional collaboration ▪ Deteriorating downtown, old suburbs	d ad ad d

(a) technological; (b) business; (c) political; (d) environmental

It is difficult to state that a given smart city model handles only one focal area (of concern) such as technological, business, political, or environmental focus. While many models tend to focus on a number of problems or concerns, the contemporary smart city models have focused on various issues

that may be divided among the following four broadly defined focus areas: a technological focus, a business focus, a political focus, and an environmental focus. Table 1 supports this observation. While there are potentially other foci (e.g., Allwinkle & Cruickshank, 2011), the categories we propose above are more prevalent than others. Despite the fact that there are some overlaps among the four foci, and admittedly the foci may need further refinement, we believe that this proposal is a useful step in the right direction. We define each focus area as follows:

(a) Technological focus

Several smart city models (Allwinkle & Cruickshank, 2011; Hollands, 2008) have considered a wide range of technological innovations necessary to make the cities smart or make citizens think or behave intelligently, by being informed about city affairs and the benefits of technologies in city affairs. This may include providing easy access to the Internet in public places, WiFi, information kiosks, digital networks for informing citizens, and the like. These and other web-based platforms that solicit each citizen's perspectives and feedback promote various forms of virtual civic engagement in city affairs. An area that can definitely benefit from technological advancements is transportation. In our auto-dependent environment, several smart city models deal with technological innovations to redefine and advance transportation. A number of universities (e.g., the University of California at Berkeley) and automakers have been involved in research studies to develop a smart highway system in order to address traffic jams and auto-related accidents (Cepolina & Farina, 2012). Other advancements result from multi-disciplinary collaboration between car makers, city officials, and urban planners. One such collaboration is to develop a smart system through coordinating vehicular technologies, traffic signals, and sensors embedded in street pavement, to reduce fatalities at street intersections that are prone to accidents (Vasseur & Dunkels, 2010). Moreover, given the fact that the elderly population is one of contemporary society's fastest growing groups, it might be necessary for scientists and engineers to investigate how technologies can make our cities and transportation systems work in a smart way to create a physical environment that promotes the health, safety, and welfare of elderly people (Lord et. al. 2011). While some researchers are looking into these issues, more studies are urgently needed. Wayfinding is another critical area where smart city technologies can be of great assistance (Mitchell, et. al., 2004). Signage systems, environmental graphics, augmented reality (AR) technologies, smart phone technologies, and the Internet, can help residents and visitors navigate and experience the physical environment of cities in a more intelligent, convenient, and enjoyable manner. Another area where technologies can play an important role is to enable various jurisdictions or agencies to work together more effectively, not just locally but regionally. Technologies can reduce overlapping tasks and bureaucracies. They can streamline review and approval processes, and they can promote more effective community outreach and communication. Moreover, technologies can encourage citizens to be more engaged in city affairs, or to volunteer for civic activities. All of these benefits can help promote a smart city by making citizens more informed, active, and responsive. One of the key challenges in this focus area is how to promote an ideal integration of virtual engagement and actual engagement that encourages citizens to visit their city so they enjoy its physical beauty, and interact with other people, not just virtually, and but also physically in public places. This area needs more work in spite of pioneering efforts by William Mitchell and other scholars (Mitchell, 1995, 2000, 2005), which still arguably remain mainly theoretical. Additional practical, implementable solutions are needed.

(b) Business focus

Making cities smart or developing technologically advanced cities cost money and require other resources. Dealing with increasingly complex city businesses require a more intelligent way of running the city. Many smart city models address business aspects of making city smarter (Thite, 2011). How to run the city businesses in a smart way is a broad and complex issue. Clearly the city is not a company. But many parts of city affairs are business-related. The city has to balance the budget. The city has to generate revenue. Among all the industry sectors other than private businesses, municipal governments (including city governments) are the entities that paid most dearly in the "Great Recession" of the last several years (Rosenberg, 2012). In the increasingly global market place, cities are competing against other cities locally, regionally, and globally. This changing geopolitical dynamic, coupled with the recent (and ongoing) Great Recession, forces cities to be smarter about running the city businesses, increasing revenues, and balancing the budget by, for example, attracting international investors. We know many examples where cities around the world invest their efforts on branding and marketing their unique products and assets in the global market. For example, Seoul, capital city of the Republic of Korea, has branded a "Design Seoul," which integrates technologies, art, design, architecture, urban planning, and business in creating a smart global city (City of Seoul, 2009).

Given the fact that efficiency is one of the key goals of this group of smart city models, one area that needs more efficiency is coordination and collaboration between various agencies or jurisdictions in municipal governments. This is where cities that are technology-focused and cities that are business-focused can collaborate. One of the challenges of this group of smart city models is learning how to increase operating efficiency, while promoting a culturally rich and diverse city life (Kuk & Janssen, 2011). The policy makers and city officials often run the risk of neglecting or compromising social capital at the expense of running an efficient city or increasing revenues (Caragliu et. al. 2011). In the name of getting things done faster or more efficiently, meaningful citizen participation or civic engagement in city affairs may be diminished or lost. Detroit is a prime example of this phenomenon, because in spite of the city's honest efforts to increase in efficiency in the city's public services (e.g., services in fire, police, sewer, water, garbage collection), their efforts failed in a significant way partly because the city did not do a good job in engaging citizens and soliciting their input and feedback on what the city was trying to accomplish in the face of a shrinking city reality. Forester (2009) argues that we should take advantage of differences of opinions or different values among different people, even if it may take extra time and effort to do so, because doing so promotes collaboration among people and eventually helps the city move towards a more efficient, productive, and civil society.

One of the challenges that business-focused smart city models face is to reduce the income gap between the haves and have-nots. Studies show that the income gap has been bigger especially during the current Great Recession, with the poor becoming poorer, and the rich becoming richer (Rosenberg, 2012), especially in cities like Detroit (Okrent, 2009). In a similar vein, the lack of social equity and a significantly higher level of unemployment among poor residents challenge efficiency as one of the primary goals of the smart city.

(c) Political focus

In recent massive protests and democratization movements by everyday people in the Middle East and North Africa, we have witnessed that people, no matter where they live, yearn for the freedom of expression and participation afforded by an open society. In an increasingly plural society throughout the world, diversity in terms of race, gender, culture, and ethnicity demands a participatory society, civic governance, and civic engagement in many aspects of city affairs (Healey, 2006; Ellin, 2010). Several smart city models pay particular attention to the complex social and political aspects of making a city smart (Caragliu et. al. 2011). The underlying assumptions of these models are that active and informed residents are smart, and that smart people will work toward smart cities. In light of such premises, these models focus on how to educate citizens, how to induce citizens to actively engage in city affairs, how to make it easier for them to share ideas about how to make their city better, how to cultivate an environment where new ideas and different perspectives may be nurtured so that citizens become better informed about making their city function more smoothly and serve them better.

Dealing with angry or scared residents, who live in a shrinking city like Detroit, however, poses many difficult challenges particularly because a rightsizing or shrinking city policy will inevitably involve relocation of some residents from neighborhoods that have extensive vacant land (Okrent, 2009). In recent years, Detroit has used various civic engagement techniques including technologies in soliciting input and feedback from residents, but the city's efforts have largely failed. More recently the city has been changing its approach and strategies for civic engagement and currently the city is in the process of deploying new strategies (DWP, 2012). The city has recently developed and launched a web-based community engagement platform (DWP, 2012; Mirviss, 2013). While this is encouraging, such a system might attract certain types of people (i.e., tech savvy residents, younger people). Many residents living in underserved areas may need to go to places like public libraries to use the Internet. A web-based tool is a great way to solicit public feedback, especially from people who are reluctant to express their opinions in front of others in a public place. Making it truly interactive is still a long way away, and the technology is not mature yet (Burd et. al., 2007; Jassem, et. al., 2010; Jassem, 2010).

(d) Environmental focus

In these days of concern for climate change and energy uncertainties the survival of our cities, regions, and even humanity, will require policymakers to explore "smart" ways of using limited resources and "smart" ways of making the physical environment sustainable. Some smart city models (e.g., Phdungsilp, 2011) deal with a broad range of environmental issues and concerns that affect our efforts to make cities environmentally smart. A common thread that cuts across these models in terms of their key assumptions is that to make the city smart will require smart people, smart technologies, and smart growth both locally and regionally, in other words a "smart" mindset (Kourtit et. al., 2012). Proponents of this group of smart city models (with environmental focus), especially the supporters of the Smart Growth model advocate conservation of natural land, preservation, and effective and careful consideration of vernacular technologies, indigenous materials, local climate, and local assets in placemaking (Daniels, 2001). These elements are intended to promote transit-oriented development, mixed-use developments, and walkable communities. In a similar vein, New Urbanists argue that transit-oriented developments expansion that encourage high density residential developments surrounded and supported by mixed-use areas (i.e., areas that are concentrated around the key nodes where major transit hubs are located) can promote a sustainable and smart city and region (Calthorpe,

2001 & 2010). While the transit-oriented development model has been received well by many policymakers and citizens in many cities, New Urbanism has been criticized by many who argue that it promotes more suburbanization, partly because New Urbanist communities have been developed mainly in suburban or semi-rural areas (Freilich et. al., 2010). In response, New Urbanists have been focusing on urban infill projects for some time, but more efforts are needed (Larsen, 2005).

Another type of urbanism that has received much attention recently is called Landscape Urbanism. The proponents of Landscape Urbanism contend that in the age of post-industrial cities such as the ones in the American Rust Belt region, cities that have extensive vacant land and deteriorating building stock and infrastructure, landscape should be used as a primary means to create a renewed, sustainable city that is healthy, productive, and creative. Such a renewed city would eventually morph into a smart city. Landscape Urbanists argue that instead of building new buildings, abundant existing buildings should be repurposed, and vacant land should be transformed into productive landscape, used for activities such as urban agriculture (Waldheim, 2006). They also contend that newly created urban greens including urban farms should be connected across the city and region to create an ecologically sound system, and that existing nodes such as major community centers or town centers should be strengthened, and connected to landscapes across the city. In the end, as the Landscape Urbanists suggest, the landscapes that currently exist, as well as the new landscapes will become parts of a green infrastructure network that connects all green spaces and preserved natural areas across the city and its larger region. As a result, the city and region will be ecologically healthy. This is, arguably, yet another way of making the city and region smart. Despite Landscape Urbanism's appeal to some cities in the Rust Belt region, Landscape Urbanism is not without criticism. In cities like Detroit that have suffered from significant shrinkage through loss of population and jobs, and the vacant land crisis in the face of an ongoing recession, landscape-based development or urban agriculture is not necessarily popular among policy makers and citizens who are faced with chronic unemployment. For example, Detroit's unemployment rate is hovering at 40% or higher in many poor neighborhoods. While Detroit is known for small community gardens and reportedly has about 1,000 gardens, Detroit still does not support the idea of large scale or industrial scale urban farms within the city perimeter. Also, there is significant resistance from the owners of small gardens and community residents against large-scale farming in the city (Okrent, 2010). Given these factors, a major challenge of environmentally-focused smart city models may be explained by asking a two-part question: a) what are the smart and effective ways to promote an ideal balance and synergy between the built environment and green and natural environment in the city; and b) how can both of these be integrated in city-making? Empirical literature on this issue is still scant, and further research is necessary.

2.2. Areas of Improvement

After reviewing the four categories of foci of smart city models discussed above, several lessons may be learned. The previous section (Analysis of Smart City Models) suggests that a better smart city model is one that would incorporate more than one focus area. For example, elements from a business-focused model and a technology-focused model could be used if city officials want to promote more collaboration among different agencies or departments. Based on the evaluation and comparison of the four groups of smart city models, we learn that weaknesses of each model may be mitigated by

incorporating strengths of other models that have a different focus. Despite their popularity, a number of popular smart city models that we reviewed seem to employ a limited focus area; one such example is a technology-focused smart city model. We suggest that in order to promote an ideal smart city, it is necessary for city government leaders to address key concerns in all four categories. Despite the fact that some overlaps exist among the models of the categories of focus, as shown in Table 1, the foci discussed there are useful because they help us better understand the scope, nature, and characteristics of smart city models. We can also use the proposed taxonomy as a way to understand and examine strengths and weaknesses of various smart city models. The classification of the smart city models can help us understand what kind of smart city model is required or desired for the relevant type of city policy or goal. The Four-Foci approach we propose requires further research, but nonetheless is a first step to obtain some synergies in the design of a smart city. While the reviewed smart city models have made contributions to the field of research into the ideal smart city or intelligent city, these models share three key limitations: lack of integration of the local and regional systems; lack of attention to holistic sustainability; lack of consideration of human factors and human and environment interaction; and inability to address significant urban changes. A more in-depth analysis is provided in the next section.

(a) Lack of integration of local system and regional systems

While smart city models generally contribute to, or address, a specific local context the models pay little attention to how to make a larger region smart. An argument may be made that, without a smart region, it would be difficult to achieve a smart city (Krueger & Gibbs, 2008). While some smart city models in the environmental focus group in Table 1 deal with regional issues, research on how a smart region beyond smart cities may be promoted and research on the relationship between the smart region and smart cities are still scant (Caragliu & Del Bo, 2012; Tranos & Gertner, 2012). All four groups of smart city models tend to be locally grounded, but their strategies in general lack regional collaboration.

(b) Lack of attention to holistic sustainability

There has been a growing concern among social scientists that, despite increasing attention to sustainability around the world, social, psychological, and political dimensions of sustainability have been neglected (Parr, 2009). It was found in this investigation that all four groups of smart city models address sustainability in one way or another. However, sustainability is defined in a limited way in each group. Despite sustainability claims made by each group of smart city models, a smart city model that advocates holistic sustainability, which incorporates social, economic, political, physical, and environmental domains of sustainability, is still rare.

(c) Lack of consideration of human factors and human and environment interactions

In each of the four groups of models, it is difficult to find mention of a smart city model that addresses how the physical environment of smart cities affects residents' behaviors and attitudes, and in what specific ways. In order to make cities smart, it may be necessary to induce citizens to think and behave in a smart way (smart thinking), as our comparative analysis of the various models has revealed. There is a large body of literature in environmental psychology and related fields that suggest that the physical environment impacts human behavior in significant ways (Gifford, 2002; Kopec,

2012). Research on how the smart city's physical features impact the thinking or behavior of the citizens, or whether the smart city can influence citizens in a positive manner in terms of their attitudes and behaviors, is still scant. We need research on smart cities in terms of human-environment interaction.

(d) Inability to address significant urban changes

While all four groups of smart city models reviewed deal with the evolution of cities in one way or the other, it is questionable as to how effective their approach to unprecedented changes such as the shrinking cities phenomenon is; this uncertainty arises from the fact that the focus or scope of each model is narrow or limited (Bugliarello, 2011). The shrinking city phenomenon has a widespread negative impact on the city like is seen in Detroit, because it affects many sectors (Okrent, 2009). Given the fact that the shrinking cities phenomenon is affecting not only cities in America's Rust Best region, but also cities around the world (Oswalt, 2005).), the role of smart cities in dealing with shrinkage is critical, worth investigating, and ought to be examined in-depth.

The following section suggests how to address the issues raised above, discusses the weaknesses or drawbacks of the models reviewed, and suggests how to develop a more robust smart city model.

2.3. Recommendations

We suggest that a more ideal smart city model should be able to address the following three key concerns or pressing matters of our and future generations: (a) major recession like the current "Great Recession," (b) public health, and (c) the challenges of urban growth or shrinkage. The following discussion suggests how to address the challenges mentioned above, and how to develop a more robust smart city model. We suggest that the abovementioned three areas of concern are critical to developing a more effective smart city model. We also suggest that there are several urbanisms that can respond to these concerns and help policymakers improve the current smart city models, building on what has been accomplished by the current models.

(a) Great Recession

Recession has left the design field unable to cope with change successfully. The field of design includes disciplines in architecture, urban design, urban planning, and landscape architecture, all of which deal with city-making. After enduring several years of the recession that has swept the world, world leaders have begun to talk about a glimmer of hope. Despite some signs of recovery, the current recession has left the design field unable to cope effectively in a timely manner. The design field has been hit especially hard by the current recession. Several smart city models (Agudelo-Vera et. al. 2011) focus mainly on the business aspects of smart cities, and they deal with smart business strategies such as expanding traditional boundaries of disciplines that deal with placemaking and citymaking. To handle the current and future recessions more effectively, city officials and policy makers need to do more than what has been done up to now. For example, they need to address the following:

■ An ideal smart city model should be able to help city government leaders develop new programs or urban physical features that use various methods or technologies in an innovative way. City officials

and policymakers should also think about how such programs and features and citizen's engagement can help create jobs. Some of the smart city models do attempt to address some of these issues (Schön et. al., 2001).

■ An ideal smart city model should help city officials educate the public about the benefits of using innovative systems or technologies to address the vacant land crisis, and ways to deal with it such as urban farming, recycling, or repurposing vacant land and properties; creating new nature conservation areas; and cleaning the contaminated soil and water. A side benefit is that all of these tasks would help create new jobs, green jobs, new hybrid jobs, or new kinds of industries that require artistic, design, management, and planning skills (Salle & Holland, 2010).

■ An ideal smart city model should incorporate a strategy for educating the public, policymakers, and design professionals about the importance of collective intelligence and collective capabilities. For example, we can educate designers about developing systems of design that can help share information and knowledge with others through a network of individuals that have an interest in a similar issue. Participants can then aid in the improvement of these systems of design and possibly find new opportunities for employment. An ideal smart city model would encourage designers to explore social media, or conventional methods integrated with social media, engage the public, and educate the citizenry about design via open source systems and social media, all of which can lead to new job opportunities. Some of these ideas can benefit from incorporating strategies from Open Source Architecture and Urbanism models (Varudouli, 2012; Nijs, 2011).

(b) Health crisis

Many advanced countries face significant health challenges. They include obesity, diabetes, and sedentary life styles, all of which are affecting cities around the world. Obesity, diabetes, and sedentary lifestyles are increasing, as we rely heavily on cars to conduct our daily business. Childhood obesity is increasing at an especially alarming rate (Frumkin et. al., 2004). Some of the smart city models examine city-making from the standpoint of how to make the city healthy. The proponents of these models advocate the idea of smart people for smart cities (Dannenberg et. al., 2011). In particular they focus on educating the public to be smart about their lifestyle and food choices, and they emphasize the environmental aspects of a smart city. In this regard an ideal smart city model should address the following.

■ An ideal smart city model should be able to help people think about the importance of engaging more actively with the space around them, especially open spaces and streets (Frank et. al., 2003). An ideal model should educate the public about the usefulness of technologies; about ways in which they can use technologies to help them exercise while working; and about ways in which workplaces and homes may be redesigned so people can get some exercise while doing other tasks. Some of the smart city models suggest that various technologies such as smart phones, AR technologies, and technologies embedded in eye glasses, shoes, or belts can help people with their health care. Likewise, kiosks, trash cans, bus stops, and the like can also have technologies that can educate the public about healthy food and lifestyle choices. Policymakers and city officials should think about how to use a smart city model

to help educate the public about those opportunities or possible healthy interventions in their daily lives.

■ An ideal smart city model should educate policymakers about the importance of providing ample space within the urban context for recreation, vegetation, and landscape, because they help create an urban oasis that provides cleaner air and lush spaces for relaxation. An ideal model should educate policymakers and the public about the importance of clean and safe air, water, and soil, which help cultivate safe and healthy food and help promote healthy environment. It will encourage people to enjoy, exercise, and explore the outdoors more frequently, and should eventually lead to a healthier lifestyle. We learn some of these ideas from Ecological Urbanism (Mostafavi, 2010).

■ An ideal smart city model should educate policymakers about the fact that the health of an individual can be improved by interaction with others in the public domain. This may be done physically and virtually. We learn that open source systems and social media create opportunities for social interaction. Social interaction reduces stress and other related illness or pathologies (Kopec, 2012).

(c) Urban growth challenges and shrinking city phenomena

Many cities around the world are shrinking (Hollander & Németh, 2011; Haase et. al., 2010). Areas that once held a large population now needs to find a way to be sustainable and productive with a smaller population in the same amount of space, and needs to address the increasing number of vacant properties, and loss of population and manufacturing industries (Leigh & Hoelzel, 2012). An ideal smart city model should address the following:

■ An ideal smart city model should educate policymakers and the public about the importance of the ability to recognize significant changes of growth or shrinkage (Ahern, 2011). To prevent the rise of the extreme and complex urban growth problem that many cities are experiencing, proponents of technology-focused smart city models argue that we need to use innovative technologies that allow us to analyze, synthesize, process, or merge complex data from diverse fields or disciplines, and also to help predict changes (Dodgson & Gann, 2011;Haase et. al., 2010). This would require multi-disciplinary collaborations and coordinated application of some of the ideas from all four groups of the smart city models that have been discussed in this paper.

■ An ideal model should educate the city officials and the public about the importance of or benefits of re-using underutilized or vacant properties for urban gardens and plants that can improve the soil and air quality. In particular, developing urban farming in vacant land and vacant buildings can create nature conservation areas that can keep the built environment healthy. Urban gardens can also be options for future development (Schilling & Logan, 2008). Ecological Urbanism teaches that ecology and nature can help the design of a more sustainable, healthy, and pleasing urban form (Mostafavi. 2010).

■ An ideal model should educate city government leaders and the public about the importance and benefits of developing long-term plans for rightsizing cities, given the fact that shrinkage and urban

growth challenges are not only a city-wide problem, but are also regional issues (Barbour & Deakin, 2012). An ideal model should also educate city officials and the public about the importance of or benefits of collective intelligence or collective capabilities via open source systems and social media (Schetke & Haase, 2008). Given increasing global economies, it will be beneficial for people around the world to be able to exchange ideas about best case examples that could spark new ideas. Detroiters, for example, could share ideas with residents of other cities that are facing similar problems of shrinkage, or other significant urban ills.

3. Conclusions

The four types of smart city models discussed in this paper can be used as a way to examine current and future smart city models. The proposed Four-Foci taxonomy of smart city models can help city policymakers identify strengths and weaknesses of various models and help them explore ways in which the models may be improved. What we learned from this stage of our research is that no matter which model is chosen, it will be necessary to incorporate strengths or assets of each of the four proposed foci (groups of smart city models), and address the challenges of each group of the models as relevant to a specific city. Another lesson is that an ideal model needs to promote a 'smart' mindset, which requires civic engagement, collaborative planning and dissemination of knowledge in the process of smart city development. In this way research can be made more visible and the idea of public visibility could be embraced more effectively in smart city planning (Deakin, 2012). Clearly many variations are possible within the proposed four groups of smart city models. Even if the same model is applied in various locations, different locations may likely yield different results. Thus an international comparison of the same smart city model(s) might be useful, given increasing globalization and interdependence of nations. Study 1 of our research was primarily theoretical in nature, as it aimed mainly to propose a conceptual model for examining the smart city models in a more holistic way. A follow-up investigation, Study 2, is planned on international comparative research on the research topic. Study 3 is planned and will focus on Phase III. Development and Phase IV. Evaluation and Conclusions. Study 3 would be more empirically-based research on smart city models, focusing on particular locations or cities.

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