DESIGNING NEXT GENERATION SMART CITY INITIATIVES - THE SCID FRAMEWORK

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Abstract Smart Cities as urban innovation and transformation initiatives aim to harness physical infrastructures, Information Communication Technologies (ICT), knowledge resources and social infrastructure for economic regeneration, social cohesion, better city administration and infrastructure management. After the first wave of flagship Smart City initiatives in different parts of the world, significant experiences and knowledge are accruing on strategies, challenges and factors for successful design and implementation of Smart Cities. However, this knowledge are yet to be systematically analysed and consolidated into a form suitable for policymakers, practitioners and other Smart City stakeholders. To address this gap, the Chapter presents a "Smart City Initiative Design (SCID) Framework" produced as one of the outcomes of an extensive study of 10 major Smart City initiatives through a Design Science Research process. The framework provides: common and recurring design objectives for Smart City initiatives; core strategies for major dimensions; enabling factors for successful initiatives and core challenges to be addressed. The SCID framework is intended as a concrete design instruments for policy makers and practitioners and concomitantly a rich source of propositions for validations in emerging Smart Cities for researchers.

Keywords Smart City Framework, SCID Framework, Smart City Strategies, Smart City Objectives, Smart City Challenges, Smart City Design

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1 Introduction

Cities worldwide are facing the challenge of rapid urbanization and need for social and economic regeneration for survival and greater competitiveness. In addressing these challenges, governments at city and other levels are initiating Smart City programs. These initiatives are directed at how the respective cities can transform themselves in different policy areas such as the use of alternative or renewable energy, use and management of natural resources, waste reduction and management, carbon emission, green areas to achieve the desired sustainable socio-economic outcomes.

However, experiences from earlier and on-going Smart City initiatives have revealed several technical, management and governance challenges arising from the inherent nature of a Smart City as a complex "Socio-technical System of Systems". While these early lessons are informing modest objectives for planned Smart Cities programs, no concrete framework based on careful analysis of existing initiatives is available to guide policy makers and other Smart City stakeholders. Existing frameworks are either conceptual, developed based only on review of Smart Cities literature, for instance (Nam & Pardo, 2011a) or they narrowly focus on the technological aspects or architecture of Smart Cities, for instance (Zygiaris, 2012). Rather than providing prescriptive Smart City framework or reference model that are detached from the realities of users, we argue that frameworks that offer users a design space consisting of a set of options for different aspects of Smart Cities Initiatives are potentially more effective. Such framework will allow users to make choices based on the realities of the environment or externalities of the Smart City program under consideration.

This chapter offers researchers, policy makers and practitioners a framework (Smart City Initiatives Design Framework - SCID) to support the planning and design of Smart City initiatives. The framework enables users to link smart city objectives with concrete impact or changes in different city aspects, and consequently city and stakeholder transformation goals. As a resource base, the framework presented in this chapter provides readers with concrete objectives, strategies and critical success factors that could be adapted by policy makers or further investigated by researchers.

The SCID Framework is grounded in the analysis of 10 flagship smart city programs around world including: Smart Amsterdam, Netherlands (Šťáhlavský, 2011); Climate Smart Malmo, Sweden (Malmo City Environment Department, 2009); Smart City Malta, Malta (SmartCity, 2014); Masdar Smart City, United Arab Emirate (Masdar City, 2011);

PlanIT Valley, Portugal (Living PlanIT, 2011); Smart City Singapore, Singapore (Mahizhnan, 1999); Smart Curitiba, Brazil (International Council for Local Environmental Initiatives, 2002); Smart Songdo, South Korea (http://www.songdo.com); Tianjin Eco-City, China (http://www.tianjinecocity.gov.sg/) and Yokohama Smart City, Japan (http://jscp.nepc.or.jp/en/yokohama/). The study is comprehensively documented in a report (Ojo, Dzhusupova, & Janowski, 2012). The framework is constructed following the Design Science Research Approach; considered appropriate when inventing or building new innovative artifacts for solving problems or achieving improvements of high relevance in an application domain (Iivari & Venable, 2009) (B. A. R. Hevner, March, Park, & Ram, 2004).

The rest of the chapter is organized as follows: Section 2 reviews the different conceptualizations of the term "Smart City" and provides a working definition. Section 3 describes our methodology for developing the SCID Framework while the details of the framework are presented in Section 4. Section 5 discusses the issues relating to the use and validation based on DSR checklist (A. Hevner & Chatterjee, 2010) before presenting the conclusions in Section 6.

2 Conceptualizing Smart Cities

This section provides the conceptual underpinning for the study and definitions of core concepts of a Smart City. The term Smart City (or Smart Cities) has been adopted by different governments, consulting organizations (IBM, 2013) and research groups. Despite the wide use of the term, its meaning remains fuzzy (Caragliu, Bo, & Nijkamp, 2009) (Nam & Pardo, 2011b). Smart City according to (Giffinger et al., 2007) is "A City performing in a forward-looking way in economy, people, governance, mobility, environment, and living, built on the smart combination of endowments and activities of self-decisive independent and aware citizens". This definition is based on the traditional regional and neo-classical theories of urban growth and development. In particular, the axes are based – respectively – on theories of regional competitiveness, transport and ICT economics, natural resources, human and social capital, quality of life, and participation of societies in cities. Based on Giffinger's definition, (Caragliu et al., 2009) offers a similar definition of the concept as follows – "We believe a city to be smart when investments in human and social capital and traditional (transport) and modern (ICT) communication infra-

structure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance".

Smart Cities are expected to dramatically improve their citizens' quality of life, encourage business to invest, and create a sustainable urban environment (Vasseur & Dunkels, 2010). Interestingly, while the term *Smart City* literarily imply an outcome or result, most usage of the term consider it as an 'activator' of change through exploring relevant open innovation processes (Paskaleva, 2011). Other conceptualizations such as (Nam & Pardo, 2011b) consider Smart City as urban innovation involving technological, organizational and policy innovation. Finally, Smart City could be understood as a certain intellectual ability that addresses several innovative socio-technical and socio-economic aspects of growth (Zygiaris, 2012).

Three elements characterizing the Smart City concept identified in (Hollands, 2008) include: 1) utilization of networked infrastructures to improve economic and political efficiency and enable social, cultural and urban development; infrastructures including ICT; 2) business-led urban development and 3) social and environmental sustainability. Social sustainability implies social cohesion and sense of belonging, while environmental sustainability refers to the ecological and 'green' implications of urban growth and development.

(Komninos, 2011) presents the concept of spatial intelligence of cities as a composite capability enabling communities within the city to harness the intellectual capital, institutions and material infrastructure in dealing with problems and challenges. Spatial intelligence is composed of three types of intelligence: 1) the inventiveness, creativity and intellectual capital of the city; 2) the collective intelligence of the city's institutions and social capital; 3) the artificial intelligence of public and city-wide smart infrastructure, virtual environments and intelligent agents. These three types of intelligence involve all dimensions of the city and maps to three types of spaces – physical, institutional and digital spaces. The "physical space" corresponds to the inventiveness and creativity of the city, the "institutional space" includes the social capital and collective intelligence of a city population, and "digital space" containing the artificial intelligence embedded into the physical environment, including public broadband communication infrastructure and digital technologies. Focusing on the digital space, (Vasseur & Dunkels, 2010) identified the following infrastructure networks for smart cities. Some of these networks are related to transport, public safety and security, public services, utilities and social networking. In the physical space, skills and human capital are considered as arguably

the most important element. For instance, it is argued that the greatest competitive advantages of cities are qualities that attract the best and brightest from the world to a city (Bloomberg, 2011). This is supported by the fact that educated cities grow more quickly than less educated ones, since skilled cities are economically more productive and better at adapting to economic shocks (Glaeser & Saiz, 2003).

As a concept, there have been a number of attempts to measure smart cities. For instance, (Lombardi, Giordano, Farouh, & Yousef, 2012) characterized smart cities as an innovation system consisting of 5 clusters – Smart Governance, Smart Economy, Smart Human Capital Indicators, Smart Living and Smart Environment and involving major actors including University, Government, Civil Society and Industry. The study provided example indicators for each cluster and actor.

Finally, works such as (Harrison & Donnelly, 2011) situates the understanding of smart cities in the tradition of studies which fundamentally views a city as a complex system characterised by interconnections, feedbacks, adaptation and self-organization. Smart Cities here provides new instrumentation that enables observations of urban systems at a micro level.

We summarize the different elements of the definitions of the Smart City concept below in Table 1. Further discussions on the conceptualizations and definitions of the Smart City are provided in (Hollands, 2008), (Caragliu et al., 2009) and (Nam & Pardo, 2011b).

Table 1: Elements of "Smart City" Definitions

No	Description	Reference
Nature	Is a (1) forward-looking City in the areas of economy, people, governance, mobility, environment and lifestyle; (2) form of urban innovation; and (3) Intellectual Capital Profile of a City	(Giffinger et al. 2007), (Nam & Pardo, 2011b), (Zygiaris, 2012)
Essence	Means (1) information access, bridging digital divide, lifelong learning, social inclusion and economic development; sustainable economic growth and urban development, higher quality of life; and wise management of natural resources; (2) innovative socio-technical and socio-economic growth of a city	(Hollands, 2008) , (Vasseur & Dunkels, 2010), (Zygiaris, 2012)
Approach	Involves (1) investments in human and social capital; (2) investment in traditional (transport) & modern (ICT) communication infrastructure; (3) promoting participatory governance and engagement of citizens; (4) technological, organizational and policy innovation	(Caragliu et al., 2009), (Nam & Pardo, 2011b)

3. Approach

The approach employed in developing the SCID Framework follows the Design Science Research guidelines and process elaborated in (A. Hevner & Chatterjee, 2010),(B. A. R. Hevner et al., 2004) and (Peffers, Tuunanen, Rothenberger, & Chatterjee, 2007). Design science in general creates and evaluates artifacts that define ideas, practices, technical capabilities and products through which the analysis, design, implementation and use of information systems can be effectively accomplished. Our objective was to create an artifact in the form a design tool to assist Smart City policymakers and practitioner in making decisions about different aspects of Smart City initiatives to achieve a set of objectives or desired outcomes. The practical relevance of the tool is related to its direct purpose of supporting the knowledge and decision needs of Smart City policymaker in Macao SAR and planning for Smart City initiatives. We summarize in Table 2 the DSR profile for the SCID Framework design process.

Table 2 Design Science Research Profile for the Study

Guideline	Description	SCID Framework Instance
G1: Design as an Artifact	DSR must produce a viable artifact in the form of a construct, a model, method or an instantiation	We develop first a Conceptual Model for Smart Cities Initiatives and a concrete Framework as a design support tool. The framework could also serves as a Knowledge Map as it maintains references to origin of options in the cases.
G2: Problem Relevance	The objective of a DSR is to develop technology-based solutions to important and relevant business problem	The SCID framework directly addresses the need of policymakers with the need to know decision options for different aspects of Smart City Initiative Design.
G3: Design Evaluation	The utility, quality and efficacy of a design artifact must be rigorously demonstrated via a well-executed evaluation method	The framework has been reviewed by the targeted users - Smart City policymakers with positive feedbacks on its usefulness. Additional field studies are planned for evaluating the tool with practitioners in different Cities.
G4: Research Contributions	Effective DSR must provide clear and verifiable contributions in the areas of design artifact, design foundations and/or design methodologies	The major constructs and relationships in the SCID framework constitute a research contribution in the Smart Cities domain. The SCID Framework contents contribute to the Smart Cities literature.
G5: Research Rigour	DSR relies upon the application of a rigorous method in both the construction and evaluation of the design artifact.	The SCID framework is grounded in findings from the analysis of concrete cases of ten mature Smart City initiatives. The analysis of the cases is based on the clearly defined conceptual model. Policy domains discovered in

		smart cities literature are used to map or streamline initiatives identified in the cases.
G6: Design as a research process	The search for an effective artifact requires utilizing available means to reach desired ends while satisfying laws in the problem environment.	Each major element of the framework was iteratively developed based on the analysis of each of ten case studies. Subsequent steps of the iteration sought to refine current contents of the framework.
G7: Communication of the research	DSR must be presented effectively both to technology-oriented as well as management-oriented audiences.	The SCID framework has been communicated to the target policymakers uses in a form of toolkit. This paper is one of the attempts to communicate same to the technology and research audience.

3.1. Research Framework

The research framework employed is an instantiation of the DSR Framework, comprising three core cycles – relevance, design and rigor (A. Hevner & Chatterjee, 2010). As shown in Figure 1, the contextual environment for our work is the Smart City Policy environment in Macao SAR, China as well the knowledge needs for the policymakers charged with the design and implementation of Smart City initiatives in the City. Macao SAR is one of the Special Administrative Regions of the People's Republic of China lying on the western side of the Pearl River Delta on South China Sea. Macao a former Portuguese colony and one of the world's largest gaming and tourism destination; has a population of about 600,000 people. It is one of the fastest growing economies of the world (about 10%) and a Purchasing Power Parity (PPP) or Gross Domestic Product per Capital of about USD82,400.00[1]. To address some of its major challenges including need for diversification and modernization of the City's economy, building very efficient transport infrastructure and creating greener environment, the City Government has since 2010 continued to build the necessary foundations for developing Smart Cities initiatives.

Our knowledgebase consists of the sources of information on all ten selected Smart City case studies and the literature related to conceptualization of Smart Cities and Smart City initiatives. The design cycle iteratively builds elements of the SCID Framework from the analysis of the cases.

[1]https://www.cia.gov/library/publications/the-world-factbook/geos/mc.html

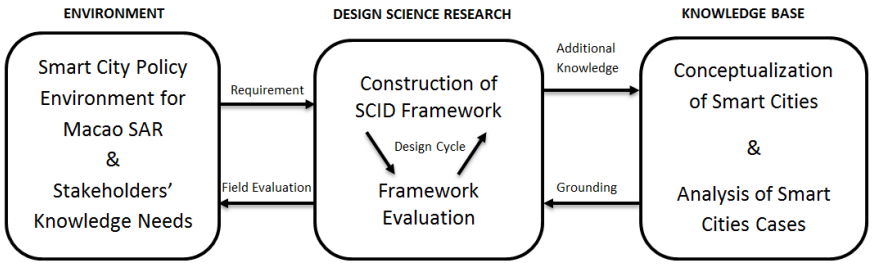

Fig. 1 The Research Framework

3.2. Design Process

Guided by the framework in Figure 1 an elaboration of the DSR methodology process model (Peffers et al., 2007), the design process proceeded in the following major steps:

1) Identification and motivation of problem
2) Definition of objectives for the framework
3) Design and development of the SCID Framework
4) Demonstration of use of the Framework
5) Evaluation of framework and
6) Communication of the framework.

As highlighted in Table 2, at least one iteration has been carried out in each step of the process. Further evaluation with larger numbers of users is underway. We have already published the artifact as a toolkit report for policymakers and aim with the current effort to disseminate the outcome of the research as a scholarly publication as part of the activity of the process.

3.3. Selected Cases - The Ten Smart City Initiatives

Given the centrality of the ten cases underpinning the design of the framework (i.e. Knowledgebase Element of our research framework), we highlight in Table 3 the profiles of the associated cities. The cases were selected based on their maturity, availability of detailed information on the respective initiatives and to some extent the interest of the target users – i.e. policymakers in Macao**.**

Table 3 Selected Smart City Programs

Program Name	City	Population
Smart Amsterdam	Amsterdam, Netherlands	- 783,364 within city, - Urban population of 1,209,419 - Metropolitan population of 2,158,592
Climate-Smart Malmo	Malmo, Öresund region, Sweden	- Third largest city in Sweden with 270,000 inhabitants
SmartCity Malta	Malta, Malta	5,600 knowledge workers (out of 412,000)
Masdar Smart City	Abu-Dhabi, United Arab Emirate	895,000 o in 2009
PlanIT Valley	Paredes, Portugal	150,000
Smart City Singapore	Singapore, Singapore	5 million
Smart Curitiba	Curitiba, Brazil	2.3 million, 1.6 million of which live in Curitiba. It is expected to reach 3.1 million in 2015
Smart Songdo	Songdo, Incheon, South-Korea	
Tianjin Eco City	Tianjin Binhai New Area, China	300,000
Yokohama Smart City	Yokohama, Japan	3.68 Million

4. THE SMART CITY INITIATIVE DESIGN (SCID) FRAMEWORK

This section presents the details of the SCID Framework resulting from the process described in Section 3.2. The framework is a solution designed to address the lack of a concrete design framework for Smart City Initiatives. It specifies major aspects of Smart City Initiatives and how the initiatives can impact specific policy domains of a City Government. The conceptual model in Fig 2 describes the core aspects of “Smart City Initiatives” that are of interest and how these aspects relate.

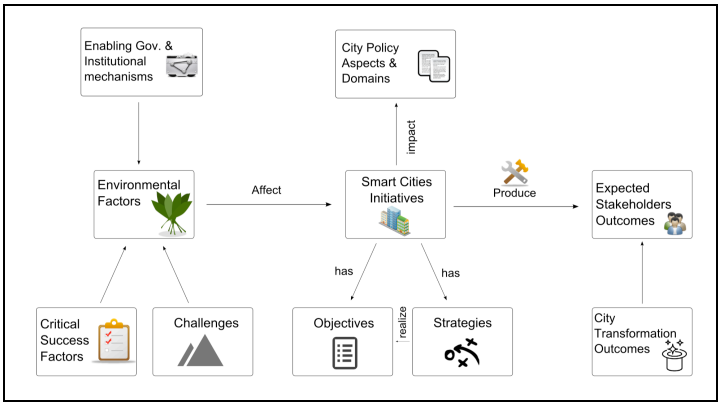

Fig. 2 Conceptual Model for Smart City Initiatives

The model was developed based on our analysis of the cases highlighted in Section 3.3. In summary, the Smart City Initiatives have clear objectives that are to be realized through concrete strategies. The initiatives are designed to impact on specify city aspects or policy domains and at the same time realize some larger City transformation outcomes and other outcomes desired by the wider stakeholders group. However, initiatives would have to address environmental factors that may pose concrete challenges and at the same consider lessons from similar initiatives in the form of catalogued success factors. Managers of Smart City Initiatives need to identify specific governance and institutional mechanisms to address the challenges and critical factors. An important aspect of the model is the explicit link between the initiatives and outcomes. This provides a value-oriented perspective to the solutions associated with the framework. The rest of the section describes elements of the framework and related design choices.

4.1. Overview

In line with the conceptual model in Fig 2, there are six major elements of the SCID Framework:

1) *Smart City Initiatives* – specific smart city related project or program to be implemented
2) *City Policy Domains* – related set of city aspects to be impacted by the initiatives

3) *Stakeholders' and City Transformation Outcome* - expected impacts on the city as a whole and desired results by wider Smart City stakeholder groups

4) *Enablers* – partnerships, institutional and governance mechanisms required to address critical factors and challenges

5) *Challenges* – difficulties that policymakers may face in implementing Smart City initiatives.

6) *Critical Success Factors* – set of conditions that significantly contribute to the success of Smart City initiatives. Both enablers and challenges contribute to understanding the critical factors.

At a practical level, each element of the Framework provides choices for the following policymaker's questions about Smart City initiatives:

Q1) What kinds of outcomes could city residents and other stakeholders desire with regards to transformation of the City?
Q2) What aspects of the City life should be transformed to achieve the desired outcomes?
Q3) What types of Initiatives can be pursued towards achieving these outcomes?
Q4) What types of concrete objectives can be set for these initiatives?
Q5) What factors contribute to successful Smart City initiatives
Q6) What are the common difficulties faced by managers of Smart City initiatives?
Q7) What are the typical mechanisms deployed to address success factors and challenges in Smart City initiatives?

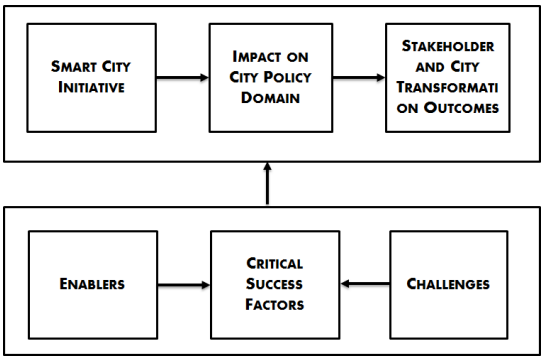

Fig. 3 The Smart City Initative Design (SCID) Framework

4.3. Elements

4.3.1. City Policy Domains

This section provides answers to the question related to aspects of the city life that should be improved to achieve the desired outcomes (Q2). These city aspects correspond to major policy areas for city governments that are usually targeted for transformation within the Smart City context. Our findings revealed the following eight primary domains:

- Economy
- Environment
- Energy
- People (intellectual endowment and skills)
- Lifestyle (Building)
- Mobility (Transportation)
- Technology
- Governance

Table 4: Dimensions Covered in Selected Smart City Programs

Program	Economy	Economy and Environment	Energy	Energy and Environment	Environment	Environment and People	Environment, Energy	Governance	Lifestyle	Lifestyle, Environment	Mobility	Mobility and Environment	Mobility, Governance, Environment	Technology	People
AMSTERDAM			■								■				
MALMO		■	■		■			■	■		■				■
MALTA	■														
MASDA CITY			■		■			■			■				
PLAN IT							■	■			■				
SINGAPORE			■		■			■	■		■				
CURITIBA		■			■	■					■		■		
SONGDO				■	■						■			■	
TIANJIN					■				■	■		■			
YOKOHAMA			■		■										

While Smart City initiatives may target a single domain, in general, initiatives would be expected to target two or more related domains. As shown in Table 4, most of the cases provide examples where two or more policy domains are targeted. The table also shows that Energy, Environment and Mobility are the domains most commonly targeted.

4.3.2. Smart City Initiatives

This section provides answer to Q3, what types of Smart City initiatives can be pursued to achieve desired outcomes. The answers are presented in two parts – the objectives of the initiatives and the strategies or mechanisms to realize those objectives.

Objectives of Smart Cities Initiatives

Across all cases, we observe that Smart City initiatives in general aim at:

1) Carbon or O_2 reduction and neutrality
2) Achieving energy efficiency
3) Leveraging ICT to develop niche industries such as those relating to multimedia contents or knowledge-based industry
4) Attaining highest quality living environment for residents
5) Developing green areas within the city
6) Developing accessible state-of-the-art information infrastructure
7) Achieving economic growth and quality of life simultaneously
8) Develop Sustainable communities
9) Ensure social harmony among different groups of residents
10) Evolving city as living laboratory to foster continued improvements.

We show in Table 5 below concrete examples of these objectives.

Table 5 Summary of Objectives of Smart City Programs

Program	Purpose
Smart Amsterdam	Focuses on CO2 reduction, energy efficiency and behavioral change. Become Europe's first "intelligent" city, with an initiative to incorporate a smart grid, smart meters, electric vehicles and "smart" building design. Reduce energy consumption in commercial properties, public buildings and areas, housing and transportation. Develop and implement sustainable and cost-effective programs that will help Amsterdam reduce its carbon footprint while exceeding the carbon reduction targets put forward by the European Union's 2020 emissions and energy reduction target.
Climate-Smart Malmo	Become a world-leading climate city and Sweden's first climate-neutral city by 2020 with respect to municipal sector activities. Exceed EU's energy target of reducing CO2 emissions by 20 % by 2020.
SmartCity Malta	Transform the Ricasoli Industrial Estate in Malta into a state-of-the-art ICT and Media business community. Facilitates ICT and media employees to develop competencies in niche sectors
Masdar Smart City	To be "smart, green city in the desert" and a model for sustainable urban development regionally and globally, seeking to be a commercially viable development that delivers the highest quality living and working environment.
PlanIT Valley	Aims to build the world's greenest city from scratch and to establish a genuine European alternative to Silicon Valley and a working template for new generation low CO2 cities. Seeks to integrate companies, education and government into the urban environment which is a major difference from the technology parks and Silicon Valley campuses. Provides stimulus for the application of advanced technologies in transforming environment and supporting innovation, skills and education. Aims at savings in both its construction and subsequent operation. It is expected to save 30-40 per cent on traditional building costs and construct buildings 30-50 per cent faster and to a much higher quality. This will also lead to significant savings in operation costs for the buildings based on the use of new materials and designs.
Smart City Singapore	Address extreme demand on urban infrastructure. To be an Intelligent Island and one of the first countries with an advanced nation-wide information infrastructure" with "interconnected computers in virtually every home, office, school, and factory". Enhance the quality of life and economic growth.
Smart Curitiba	Aims at sustainable development and integration of Curitiba's metropolitan region. Address a rapidly increasing demand for improving urban services caused by population and economic growth.
Smart Songdo	Aims to be an urban living space that is intelligent, green and self-sufficient, where eco-friendliness and energy savings are key characteristics of the zone.
Tianjin Eco City	Aims to serve as a model for future developing Chinese cities that is socially harmonious, environmentally friendly and resource-conserving. It is designed to be practical, replicable and scalable, so as to serve as a reference for other cities. Vision is to be "A thriving city which is socially harmonious, environmentally-friendly and resource-efficient – a model for sustainable development". This vision is underpinned by the concepts of "Three Harmonies" and "Three Abilities".
Yokohama Smart City	Address urban problems including pollution, traffic congestion, inundation and solid waste management. Consolidate on post-earthquake and World War 1 reconstruction

Exemplar Strategies for major dimensions

We provide here examples of strategies to realize the objectives presented above. Complete listings of strategies are provided in the practitioner's SCID Framework Toolkit Document. Below we describe the strategies for the most common policy domain; Environment, Energy, and Transport.

Environment – This dimension is associated with seven categories of strategies including:

1) Water management
2) Open and green space development
3) Material flow and recycling
4) Sustainable city operations
5) Land use planning
6) Sustainable agriculture and natural resource management
7) Waste management

Table 6 provides strategies for the environment dimension and the information on the sources of the strategy.

Table 6 Strategies for Environment Dimension

Initiative	Strategies
Waste Management	Waste separation into dry recyclables; wet recyclable, residuals & solid waste (Masdar) (Curitiba)
	Designed to encourage recycling in low-income areas where it was more difficult to reach by the conventional waste management system (Curitiba)
	Involve children in the program by exchanging recyclable garbage for school supplies, chocolates, food parcel (Curitiba)
	Hires retired and unemployed residents temporarily to clean up specific areas of the city where litter has accumulated (Masdar)
	Minimizes the amount of waste, makes reuse and recycling possible and enables the use of waste and sewage as an energy source (Malmo)
	Construction of waste separation system in buildings (Malmo)
	Food waste is primarily collected to produce biogas for vehicle fuel (Malmo)
Open and Green Space	Build a Central Park is a large 100-acre green space the city's centerpiece, which was modeled after New York City's Central Park (Songdo)
	Ensure that all blocks to connect pedestrians to open space, walking/biking corridors and public gathering areas. (Songdo)
	Design open spaces and public gathering areas are arranged to optimize access to sunlight, views and open sky (Songdo)

	Provide 40% open space to maximize the connection to nature within the city for residents, workers and visitors. (Songdo)
Material Flow and Recycling	75% of construction waste is targeted to be recycled (Songdo)
	Recycled materials and locally produced/manufactured materials will be utilized to the maximum extent possible (Songdo)
	Portland cement reduction of 20% or more through the utilization of flash-content concrete. (Songdo)
	Low-VO (Volatile organic compound) materials incorporated into buildings (Songdo)
Environmental Sustainability	Implement Sust. Singapore plan. The key targets are: 1) 35% reduction in energy intensity from 2005 levels, 2) raise overall recycling rate to 70%, and 3) introduce 50ha of skyrise greenery. (Singapore)
Land use Planning	Provides a land-use plan that based on transit-oriented development. (Tianjin)
	Create centers for each district where local and centralized facilities are provided to serve the needs of residents in each neighborhood.
	More land will be converted to organic agriculture. Crop-free and pesticide-free zones in the agricultural landscape will benefit biological diversity and reduce the spread of nutrients and toxins into watercourse and groundwater (Malmo)
	Biological diversity will be preserved and developed hand in hand with nature protection and nature management (Malmo)

Energy – Strategies for this dimension include adoption of energy efficient practices particularly in building designs, use of renewable energy such as biogas and wind energy by households, use of smart grid technologies, deployment of energy management system at the community, building ad home levels, education of children through projects on how to save energy and promotion of the use of e-vehicles and hybrids. Table 7 provides the full listing of the different strategies for the energy dimension.

Table 7 Strategies for Energy Dimension

Initiative	Strategies
Intelligent Energy Management	Minimizes energy consumption by deploying the best commercially available international energy-efficient techniques and setting stringent building efficiency guidelines (Masdar)
	City is powered currently by onsite renewable energy. (Masdar) (Malmo)
	As the city grows it is targeted that at least 20% of energy supply will come from onsite renewable sources with remaining power sourced from offsite renewable sources (Masdar)
	Develop and test new smart grid technologies and solutions by integrating modern information and communication technology with the power system to allow two-way communication between electricity consumers and grid operators (Singapore) (Yokohama)
	Introduction of Home, Building, and Community Energy Management Systems (Yokohama)
Energy	Compensating greenhouse gas emissions from municipal activities through in-

	creased investments both in renewable energy (Malmo)
	Testing green tools for cities to adapt to climate change (Malmo)
	Transition from fossil natural gas to renewable biogas and later to hydrogen (Malmo)
	Introduce large quantities of renewable with Solar Heating (Yokohama)
	Next generation transportation with e-vehicles - Charge and Discharge Evs (Yokohama)
	Promoting lifestyle change (Yokohama)
	Developing appropriate Governance structure (Yokohama)
Sustainable Living	Aims to supply 8,000 households with renewable energy (Amsterdam)
Sustainable Public Space	Smart street incubator testing ground for new climate friendly innovations & experiment (Amsterdam)
	Smart school project where children can learn about saving energy (Amsterdam)

Transportation – Smart transportation strategies adopted by the programs include focusing on accessibility rather than mobility in transportation planning, provision of networks for non-motorized transportation (bicycles and walking), prioritization parking for fuel-efficient and low emitting vehicles in public places, use of e-vehicles for public transport with charging stations provided across the city, integration of land-use and public fare collection and adoption of transit-oriented development in urban planning. Table 8 provides the list of strategies for the transportation domain.

Table 8 Strategies for Transportation Dimension

Initiative	Objective
Smart Transportation	Increase accessibility rather than mobility (Curitiba)
	Allow subway line Songdo IBD to run through the center and expanded City bus service will enhance the easy access to surrounding areas. Incheon International Airport will also be accessible from Songdo via sub-way and bus service (Songdo)
	Build 25 km network of bicycle lanes to facilitate safe, carbon-free transportation (Songdo)
	5% of parking capacity within each project block will be set aside as parking for fuel-efficient and low-emitting vehicles. Office and commercial blocks will reserve an additional 5% of parking capacity for carpool vehicles (Songdo).
	Locate packing underground or under a canopy to minimize the urban heat island effect and maximize pedestrian-oriented open space above ground (Songdo).
	Integrate infrastructure for electrical vehicle charging stations into parking garage designs to facilitate the transition to low emissions transportation (Songdo) (Amsterdam)
Transportation	Provides transport within the city including fuel efficient electric or hybrid buses, electric cars, and other clean-energy vehicles (Masdar) (PlanIT Valley)

	Private vehicles will be kept at the city's edge in parking lots that will be linked by public transportation to the rest of the city. (Masdar)
	Reduce need for transportation by providing different types of services & recreation (Malmo)
	Advocacy on the use of environmentally friendly mode of transportation by providing diverse measures such as walking cycling, and use of public transport (Malmo)
	Intelligent traffic system enabling communication between buses and traffic lights for higher priority in getting green light signals (Malmo)
Transport Management	Create a public transport system integrates effective land use principles with advanced public transport fare collection. (Singapore)
	Integrate higher-density housing and commercial developments with rail transit for greater convenience and accessibility. (Singapore)
	Improve transportation-related decision making through simulation of human and commercial activities, transportation, energy use and impact on the environment. (Singapore)

4.3.3. Implementation approach

This section briefly examines development and transitional approach to smart cities. There are two predominant approaches to smart city development:

1) Top-down model – requiring that smart cities are planned, designed and developed based on some blueprints;
2) Bottom-up model – involving retrofitting existing cities with smart features.

Examples of the smart cities initiatives based on the Smart Cities approach include the Masdar City in Abu Dhabi, New Songdo in South Korea and PlanIT Valley in Portugal.

Bottom-up approaches challenges the conventional top-down approach based on the premise that *"smart and real cities are not like army regiment marching in lock-step orders, they are more like a shifting flock of birds or school of fish in which individuals respond to subtle social and behavioral clues from their neighbors about which way to move forward*" (Ratti & Townsend, 2011). In the bottom-up scheme, people or city inhabitants acts as agent of change in creating smart cities. With support infrastructure, the populace can tackle problem of energy use, traffic congestion, healthcare and education. Residence in a connected community can exploit their distributed intelligence to evolve activities (Ratti & Townsend, 2011). Bottom-up scheme for building smart cities involves:

- Relying on smart devices carried by people as sensors rather than relying only on formal systems embedded into infrastructure, e.g. using the traffic function of Google Map and exploiting peer-to-peer sensory data sharing
- Citizen-to-Citizen service delivery, for example using the Boston 311 application to make request to government which could also be responded to by fellow citizens
- Making government private data warehouses public to empower entrepreneurs and listening to citizens to frame their own smart city vision

To support top-down development of smart cities, (Zygiaris, 2012) presents a reference model for defining the conceptual layout of smart cities and an architecture for linking or inter-relating issues of green cities, connected life, intelligent communities, innovation ecosystems, and environmental and social sustainability with urban growth. The reference model identifies 6 layers:

- Layer 0: The City
- Layer 1: The Green City Layer
- Layer 2: The Interconnection Layer
- Layer 3: The Instrumentation Layer
- Layer 4: The Open Integration Layer
- Layer 5: The Application Layer
- Layer 6: The Innovation Layer

The reference mode is similar to the architecture described in Smart cities project which integrates three layers corresponding to: 1) Physical City comprising people, activities and infrastructure; 2) Innovation ecosystem comprising four processes – watch, learn, innovate and market; 3) Applications and embedded systems comprising four types of applications – intelligence, e-learning, co-creation, and marketplace.

4.3.4. Stakeholders and City Transformation Outcomes

This section provides answers to Q1 on the type of outcomes desired by stakeholders of Smart City initiatives. Recognition as good practice exemplars featured prominently in the reported outcomes by these programs. These recognitions, which are based on benchmark rankings on smart cit-

ies, are considered valuable by the different programs. Other outcomes associated with the programs in different areas are presented in Table 9.

Table 9 Summary of Desired Outcomes from Smart City Programs

Environment	Aesthetic value	**Energy**	E-Vehicle adoption
	Recycling take-up by residents and businesses		Level of biogas production
	Green space per residential unit		Use of wind energy
	Recognition - ranking and designation as best practice exemplar		Energy usage reduction
	Adoption of organic food		Petrol usage reduction
Transportation	Less congestion	**Economy**	Standard of living
	Less CO2 emission		GDP contribution
	Self-sustainability		Unemployment rate
	Recognition – ranking and designation as best practice exemplar		Investment friendly environment
			Recognition – including competitiveness
			Employment and job creation
			Foreign Direct Investment
			Startups

4.3.5. Enablers

This section provides answers to Q7 on mechanisms for addressing the success factors and challenges. The core mechanisms including partnerships and governance mechanisms are discussed below.

Partnership for smart city programs

Smart City programs are complex and involve a wide range of partners and stakeholders playing different roles. The nature of partners involved in smart city programs include: academia (university and research centers), state-owned enterprises, real-estate firms (e.g. Gale International), architectural practice firms, investment firms (e.g. TECOM investment), engineering construction firms, technology firms (e.g. CISCO, IBM, Microsoft, Hewlett Packard), international consulting firms (Accenture, Mott MacDonald), government departments and agencies, other governments (e.g. Singapore). While some smart city programs are driven by private

sector (e.g. in Malta and PlanIT Valley), government entities always play pivotal roles. Table 12 provides examples of the partners for some of the selected programs.

Table 12 Examples of Partners for Smart City Programs

Program	Partner	Partner Type	Partner Role
Curitiba	Curitiba Research and Urban Planning Institute	Academia-Research Institute	Master plan development
	Mayor	Host Government	Coordination
	URBS Urbanizao de Curitiba (URBS)	State-owned Enterprise	Infrastructure maintenance and oversight on bus companies
Songdo	Gale International	Real estate	Main developer
	Korea's POSCO Engineering & Construction company Ltd	Private Sector	Setting up Songdo International City Development (NSIC) as Joint Venture Company in 2002
	Cisco	Private Sector	Create advanced community connected by IT
	Kohn Pedersen Fox Associates	Private Sector	Architectural Design of Sogdo IBD
	Songdo U-Life	Quasi Private Sector	Building of ubiquitous infrastructures & ubiquitous environment for u-services
Masdar	Masdar Venture	Private Sector	Economic diversification via Renewable energy
	Masdar Institute	Academia – Research Institute	Science & engineering of advanced alternative
	Mott Macdonald	Private sector – Engineering firm	Engineering
Singapore	Ministry of National Development	Host Government	Plan, regulate, facilitate & execute development projects
	Urban Redevelopment Authority	Host Government	Promote architecture and urban design excellence.
	Economic Dev. Board	Host Government	Planning and executing strategies to enhance Singapore's position as a global business center
	IBM	Private Sector	Partner on Smarter City Initiative
	Singapore MIT Alliance for Research and Technology	Academia – Research Institute	MIT-supported research in urban mobility system
	Microsoft	Private Sector	Software

Think-tank support

At least four of the smart city programs explicitly developed research and development think-tanks to support the implementation of the respective programs – Smart Curitiba, Masdar Smart City, Smart City Singapore and Plan IT Valley. To support the Smart Curitiba program an institution was created to support the development of the master-plan and the long-term implementation of the master-plan. The Masdar Smart City program also works in partnership with the Masdar institute for its research and innovation needs. The Smart City Singapore program collaborates with Nanyang Technological University, while the Plan-IT Valley initiative integrates research into its operations based on the Living Lab framework. In fact, the Smart Curitiba program considers research-support as a critical success factor.

Governance

Governance actions constitute the second categories of mechanisms. Four types of governance actions these have been identified across studied programs:

1) Coordination and integration
2) Service integration
3) Participation and co-production
4) Policy and regulations

- Coordination and integration actions in smart city programs includes identification of an agreed set of projects by stakeholders across sectors, use of administrative and legal instruments for conformance and integrated planning practices involving multiple sectors. Service integration approaches included integrated utility management and use of Urban Operating Systems (UOS) in managing and integrating urban services. Participation and co-production actions include building multi-stakeholders partnerships with industry, academia, and residents in addition to the participation of internal firms in the development of smart cities. Lastly, policy and regulatory actions include master-planning, institutional development, certification of practices (e.g. buildings), promotional activities (e.g. low carbon growth), and development of framework acts. Specific examples are presented in details in

the toolkit (Ojo, Janowski, & Dzhusupova, 2012). A summary of governance actions are provided Table 13.

***Table* 13** Governance Actions to support Smart City Programs.

Element	Action
Coordination and integration	Human centered approach
	Identification of agreed core set of projects
	stakeholder involvement
	use of administrative and legal instruments
	Integration of policy implementation in multiple dimensions - transport, land use, road network etc. OR integrated planning
Service Integration	Integrated utility management
	Integrated land use and transport services
	Operating System or Control System for integrating and managing all urban services
Participation and co-production	building multi-stakeholder partnerships with industry, academia and residents
	Information exchange
	Citizen or resident participation
	Local and international firm participation
	Agency collaboration
Policy and regulations	Visioning and Master-planning
	Providing certifications for different types of practices or activities
	Institutional development
	License regulations (e.g. in transportation)
	promotional activities, e.g. adopting like low-carbon growth policies
	Developing Framework act
	design and engineering standards

4.3.6. Challenges

This section presents the answers to Q6 on common difficulties faced in Smart City initiatives. A number of challenges were identified across reviewed programs. These challenges include: 1) obtaining buy-in from stakeholders, particularly the private sector; 2) inclusion of poor areas in the program; 3) sustaining stakeholders' interests and participation; 4) resourcing and funding the program considering high development cost; and 5) obtaining residents participation. Specific examples are presented in Table 11.

Table 11 Challenges associated with Smart City Programs

Program	Challenge	Keyword
Curitiba	Since changing circumstances require new approaches, Curitiba's most important future challenge is to continue cooperation among a wide spectrum of people and organizations in order to foster economic prosperity	Sustained multi-stakeholder cooperation
	Integrating poor areas and shanty towns in city periphery including those not connected to the sewer system.	Coverage of poor areas
Songdo	Hard-wired broadband infrastructure makes development more costly for both the city and individual developers, which may translate into more expensive prices for buildings such as offices, residential or commercial	High development cost
	Creating value for Private sector - "for a public sector undertaking, one needs to create value for the private sector to want to be engaged and invest in the real estate".	Value to Private sector
	The most difficult part is really the alignment of interests and commitment to a plan on the outset; getting everybody aligned behind it--[in terms of] what is this level of development going to be, how are we going to ensure all our partners live by the guidelines, and what the anticipated outcomes are	Aligning interest parties
Masdar	Global economic slowdown due lack of capital and lower prices of oil.	Lack of capital
Singapore	How to continue to sustain economic growth and ensure a high quality of life through careful planning.	Balanced growth
PlanIT Valley	PlanIT Valley faced many challenges, not least in terms of convincing others that this vision can become a reality	Buy-in from stakeholders
Tianjin	Setting suitable targets for the eco-city and putting in place an effective monitoring system - targets must be sufficiently-stretched so that high standards are set and the eco-city can minimize its carbon emissions and resource utilization to the lowest levels achievable. At the same time, due consideration must also be given to local conditions, as well as the impact of the higher standards on the cost of doing business in the eco-city	Target setting
	Ensuring that eco-city is sustainable long after construction is completed and it can still meet its KPIs and continue to provide a pleasant living & working environment for its residents after completion of physical development	Program Sustainability
	Effective mobilization of residents to support and reinforce policies and programmes and to help meeting its KPIs and making the eco-city the home of choice for its residents. City must have the cooperation and support of its residents in waste reduction, and resource recycling and management.	Resident Participation

4.3.7. Critical success factors

This section presents the answers to Q5 – the success factors for smart city programs. Analysis of the success factors across cases show that: 1) Political leadership and 2) the adoption of integrated, holistic and whole of government approach to smart city development stand out as critical factors. Other identified factors include – 3) creation of dedicated research and think-tank institution to support program, 4) non-compromise on core values, 5) ensuring creativity but affordability of solutions, 6) comprehensive master-planning, 7) regulations and standards for stakeholders, and 8) building stakeholder collaboration and industry partnerships. Examples from cases are provided in Table 10.

Table 10 Success Factors for Smart City programs

Program	Success Factor	Keyword
Curitiba	Leadership and adherence to smart transportation planning has helped Curitiba strive towards be-coming a sustainable city while gaining its strong reputation as a great example of successful urban planning	Leadership and Adherence to Plan Implementation
	IPPUC's creation was an essential to ensure long-term implementation of city plans. IPPUC was effective in ensuring planning continuity and success regardless of political, economic and social challenges, and made substantial contributions as a laboratory for finding creative, integrated solutions to urban planning problems.	Creation of research and Think-tank Institution
	The combination of core values expressed in the city plan and IPPUC's creation allowed planning for efficiency and sustainability even in difficult circumstances. Commitment to local values such as accessibility, transparency, social justice and poverty reduction and efficient resource management are what resulted in Curitiba's sustainable development, which is more than simply "environmental."	Non-compromise to Core values
Masdar	Collaborate with a range of partners who share the vision and commitment	Collaboration
Singapore	Successful water management program would not be possible without institutional reform, such as the adoption of demand management in the new water tariff setting, i.e. removal of subsidy for domestic users.	Institutional reform
	Comprehensive and long-term planning to ensure economic competitive and quality of life at the same time.	Holistic long term planning
	Prudent land use planning enabled Singapore to enjoy strong economic growth & social cohesion, & ensures that sufficient land is safeguarded to support continued economic progress and future development	Prudent land use

5. DISCUSSION

First, we highlight our experience in using the DSR approach in developing the SCID Framework. Our experience shows that the method not only enables a clear rigorous process for building the artifact but also enabled detailed attention to our targeted users' needs. However, while we set out to use our cases only as a knowledgebase for grounding our artifact, we discovered that the cases were also a rich source of information on the potential needs of the users, and subsequently provided a detailed requirement specification for a Framework.

Second, feedback from users revealed that the options provided by the SCID Framework are useful and the use of the framework is aligned with their IT Management practices in areas such as portfolio management, strategic alignment, and benefits management.

Third, as we argued in the Section 1 our objective was not to provide, at least explicitly, a prescriptive model, but rather offer possible choices as answers to the questions that Smart City policymakers have on developing initiatives. Although, the users found the options provided useful, rigorous internal evaluation of the tool revealed that there might be the need to better support how specific choices of the options are decided upon with respect to critical success factors and challenges. Specifically, consider techniques that are used to support decision making in the context of several factors such as the Analytical Hierarchical Process (AHP) (Vaidya & Kumar, 2006) as useful for linking for the environmental factors and strategic choices offered the framework.

Fourth, as the SCID framework relies heavily on a knowledgebase of analysis of initiatives, the effectiveness and freshness of the choices offered by the tool will depend on how it is able to capture new knowledge from emerging and future smart city initiatives. Our current plan is to update the framework periodically as triggered by requests from users. However, we consider for the longer-term a more participatory, crowd-sourced and social approach for the dynamic update of the SCID Framework.

Finally, we intend to carry out further dissemination and evaluation of the tool with Smart City Initiatives managers in the context of an International Collaboration Program involving Smart City practitioners and researchers across cities aiming to develop Smart City programs.

6. CONCLUSIONS

This chapter has presented in some details a framework that has systematically captured the outcomes of the detailed analysis of 10 smart city initiatives. Conclusions from the contents of the framework and underpinning findings include:

- Energy, Environment and Mobility are focal areas for Smart City initiatives, implying strong focus on Sustainability.
- While integration of policy domains is the holy-grail for Smart City design, our study suggests that smart city initiatives primarily focus on one domain and two related domains, such as Energy and Environment in a few cases.
- Smart City initiatives involve a wide array of stakeholders including from Urban Development and Real Estate, ICT, Investment sectors, making the management of their various interests complex.
- The business case of including poor areas in the Smart City initiatives are still very to make, thus making the phenomenon of "Smart City islands in the sea of urban slum" a possible urban reality in some parts of the world.

As a conceptual framework, we have adopted the SCID framework in studying open data programs designed as Smart City Initiatives. We adopted the major constructs of the framework for documenting these initiatives and analyzing their impacts. In this regards, we found the SCID framework complementary to the Smart City initiative Framework described in (Alawadhi et al., 2012). Based on this experience, we consider the SCID framework as a general tool that could be used in any context as a conceptual instrument. As a practical guide, the framework contents presented in Section 4 provides good starting points for smart city decision makers in developing specific objectives and strategies to meet their peculiar city transformation goals. It is plausible to expect that additional enablers, barriers and critical factors would apply in different environments.

Given the nature of the SCID Framework as a knowledge product, its practical usefulness is contingent only period updates based on analysis of new emerging cases of Smart City initiatives. Practical approaches to enable such updates in an efficient manner are currently been investigated.

References

Alawadhi, S., Aldama-nalda, A., Chourabi, H., Gil-garcia, J. R., Leung, S., Mellouli, S., … Walker, S. (2012). Building Understanding of Smart City Initiatives. In *IFIP EGOV 2012* (pp. 40–53). LNCS 7443.

Bloomberg, M. R. (2011). The Best and the Brightest - New York City's bid to attract science talent could serve as a model for other cities. *Scientific American*, *305*(3), 11.

Caragliu, A., Bo, C. Del, & Nijkamp, P. (2009). Smart cities in Europe. In *3rd Central European Conference on Regional Science - CER 2009* (pp. 45 – 59).

Giffinger, R., Fertner, C., Kramar, H., Kalasek, R., Pichler-Milanović, N., & Meijers, E. (2007). *Smart cities Ranking of European medium-sized cities*. *October* (pp. 1–28).

Glaeser, E. L., & Saiz, A. (2003). *The Rise of the Skilled City* (No. No 25). *Social Science Research*. Cambridge, Massachusetts.

Harrison, C., & Donnelly, I. A. (2011). A Theory of Smart Cities. In *55th Annual Meeting of the International Society for the Systems Sciences 2011* (pp. 521–535). Hull, United Kingdom.

Hevner, A., & Chatterjee, S. (2010). Design Research in Information Systems. In *Integrated Series in Information Systems* (Vol. 22, pp. 9–23). Boston, MA: Springer US. doi:10.1007/978-1-4419-5653-8

Hevner, B. A. R., March, S. T., Park, J., & Ram, S. (2004). Design Science in Information Systems Research. *MIS Quarterly*, *28*(1), 75–105.

Hollands, R. G. (2008). Will the real smar tcity please stand up? Intelligent, progressive or entrepreneurial. *City: Analysis of Urban Trrends, Culture, Theory, Policy and Action*, *12*(March 2012), 37–41. doi:10.1080/13604810802479126

IBM. (2013). Smart Cities. Retrieved November 12, 2013, from http://www.ibm.com/smarterplanet/us/en/smarter_cities/overview/index.html

Iivari, J., & Venable, J. (2009). ACTION RESEARCH AND DESIGN SCIENCE RESEARCH –. In *17th European Conference on Information Systems* (pp. 1–13).

International Council for Local Environmental Initiatives. (2002). *Curitiba: Orienting Urban Planning to Sustainability*. *Challenge* (pp. 1–6). Toronto.

Komninos, N. (2011). Intelligent cities : Variable geometries Intelligent cities : Variable geometries of spatial intelligence. *Intelligent Buiildings International*, *3*(March 2012), 37–41. doi:10.1080/17508975.2011.579339

Living PlanIT. (2011). Living PlanIT at Cisco C-scape.

Lombardi, P., Giordano, S., Farouh, H., & Yousef, W. (2012). Modelling the smart city performance. *Innovation: The European Journal of Social Science Research*, *25*(2), 137–149. doi:10.1080/13511610.2012.660325

Mahizhnan, A. (1999). Smart Cities: The Singapore Case. *Cities*, *16*(1), 13–18. Retrieved from http://www.spp.nus.edu.sg/ips/docs/pub/pa_Arun_Smart Cities The Singapore Case_99.pdf

Malmo City Environment Department. (2009). *Environmental Programme for the City of Malmo 2009-2020*. *City*. Malmo. Retrieved from www.malmo.se/miljoprogram

Masdar City. (2011). *Exploring Masdar City* (pp. 1–93). Masdar.

Nam, T., & Pardo, T. (2011a). Conceptualizing Smart City with Dimensions of Technology, People and Institutions. In *The Proceedings iof the 12th Annual Conference on Dogital Government Research* (pp. 282 – 291). MD, USA: ACM Press.

Nam, T., & Pardo, T. A. (2011b). Smart City as Urban Innovation: Focusing on Management, Policy and Context. In E. Estevez & M. Janssen (Eds.), *Proceedings of the 5th International Conference on Theory and Practice of Electronic Governance (ICEGOV2011)*. Tallinn, Estonia: ACM Press.

Ojo, A., Dzhusupova, Z., & Janowski, T. (2012). *e-Macao Report 198 - Intelligent Governance of Smart Cities - State of Practice*. *City* (Vol. 12, pp. 1–100). doi:10.1080/13604810802479126

Ojo, A., Janowski, T., & Dzhusupova, Z. (2012). e-Macao Report 200 - Intelligent Governance of Smart Cities - Development Framework (pp. 1–30).

Paskaleva, K. A. (2011). The smart city : A nexus for open The smart city : A nexus for open innovation ? *Buildings*, *3*(March 2012), 153–171. doi:10.1080/17508975.2011.586672

Peffers, K., Tuunanen, T., Rothenberger, M. a., & Chatterjee, S. (2007). A Design Science Research Methodology for Information Systems Research. *Journal of Management Information Systems*, *24*(3), 45–77. doi:10.2753/MIS0742-1222240302

Ratti, C., & Townsend, A. (2011). The Social Nexus. *Scientific American*, *305*(3), 30 – 35.

SmartCity. (2014). SmartCity Malta. Ricalsoli, Malta. Retrieved from http://malta.smartcity.ae/

Šťáhlavský, R. (2011). Amsterdam Smart City Project. *Accenture: High Performance. Delivered*, (May).

Vaidya, O. S., & Kumar, S. (2006). Analytic hierarchy process: An overview of applications. *European Journal of Operational Research*, *169*(1), 1–29. doi:10.1016/j.ejor.2004.04.028

Vasseur, J.-P., & Dunkels, A. (2010). Smart Cities and Urban Networks. In *Interconnecting Smart Objects with IP - The Next Internet* (pp. 335–351). Morgan Kaufmann. doi:10.1016/B978-0-12-375165-2.00022-3

Zygiaris, S. (2012). Smart City Reference Model: Assisting Planners to Conceptualize the Building of Smart City Innovation Ecosystems. *Journal of the Knowledge Economy*. doi:10.1007/s13132-012-0089-4