Establishing Smart City Technical Standards and Guidance: A Way Forward

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ABSTRACT
Solving technical problems with complex systems and integrating the many technologies employed in these multifaceted structures has been a recurring theme in Smart Cities research. This paper presents an analysis of the reason this problem has been so well explored but persists with no solution widely available. The problem is viewed as a combination of Smart City needs, governance, and increasingly technically difficult decisions. The paper describes the requirements that must be met to develop a framework that can address this seeming intractable and expanding integration concern, identifies the governance processes that can be used to address this problem, and to manage integration in Smart Cities, The solution proposed is a formalized accepted and managed technology regulated environment introduced by governance groups composed of city planners/managers, citizen, stake holders, and technology delivery organizations. The solution requirements dictate the establishment of a standard that would guide the development and usage of automated, autonomous components, integrating dynamically with software agents. All of this working to rapidly optimize shared resources through error handling processes executing largely at no cost except those of processing time, meeting safety guidelines, satisfying operational monitoring needs, and meeting post issue liability guidelines. This technical standard would obligate developers and vendors to meet safety standards and accept liability for malfeasance. As initiating steps, Smart City managers must come together and establish a basic understanding of the goals and regulations, and the methodologies for implementing them.

CCS Concepts
• Applied computing→E-government • Information systems →Extraction, transformation and loading • Information systems~Data exchange • Information systems→Data cleaning • Information systems→Specialized information retrieval • Security and privacy→Information accountability and usage control • Security and privacy~Software security engineering • Human-centered computing→Contextual design

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Keywords
Standardization, Interoperability, Mediators and Data Integration, Data Exchange

1 INTRODUCTION
A great deal of effort has been placed on addressing the challenges of cities including investing in infrastructure and technology to improve the performance of the city on six characteristics of economy, people, governance, mobility, environment and living that are each composed of subordinate factors with assessable indicators. [1] In 2015 the White House recognized the emerging community of civic leaders, data scientists, technologists, and companies that were assembling infrastructures to collect, and aggregate data from all sources (sensors to social media) to support Smart Cities and improve the lives of citizens. [2] The White House announced a number of research, demonstration, and collaboration projects to further the Smart Cities efforts. In February of 2016, the U.S. President's Council of Advisors on Science and Technology called for the development of a platform for Smart City collaboration that would include all relevant stakeholders sharing results, insights, and best practices. They envisioned a bottom up mechanism that will foster innovation that would meet appropriate technical standards. Their vision, called the City Web, sought to ameliorate technology-adoption challenges, and "…illuminate new directions for place-based policy…" and leverage investments to renew infrastructures that incorporate innovations rather than merely replace old and failing systems. [3, transmittal letter.]

This call to action was issued because other Smart City initiatives are not fully successful. As Nam and Pardo [4] discussed, Smart City initiatives drive innovation and seek to manage the accompanying risks. They note that previous research has underestimated the new technological and networked infrastructures needed for a city to be "Smart" further positing that Smart City initiatives may introduce complexity with the development of unexpected emergent properties leading to failures in technology-driven public sector projects. As Rayal recently noted cities implement technologies with long life-cycles driven by intricate business cases, and that evaluating the technologies is time consuming and thus creates a cascading flow that stalls implementation. [5] Further, many Smart City initiative are focused primarily on automating existing services in the hope of netting fiscal savings. Smart City solutions must not only provide the technical solution but do so in a way that does not interfere with other solutions, increase costs, or create a future burden on the city. This paper proposes a set of

implementable recommendations to govern smart program technical decisions and promote interactive and highly integrated solutions through minimal standards, regulation, and laws to improve development of consistent, and interoperable Smart City solution implementations. In this manner, Smart Cities can also utilize newer technologies and capitalize upon the promise now being realized in the commercial world of cloud computing. This emerging IT Platforms views computing as a 5th utility [6] applying a model consisting of services that are commoditized and delivered in a manner similar to traditional utilities such as added to water, electricity, gas, and telephony. In such a model, users accesses services based on their requirements without regard to where the services are hosted or how they are technically implemented and delivered.

2 BACKGROUND

Smart City solutions focus on urban environments with complex problems that research has shown can be categorized on six characteristics of economy, people, governance, mobility, environment and living that are each composed of subordinate factors with assessable indicators. [1]. The characteristics provide possible visions of solution sets that can deliver services to large numbers of people, business, and entities. As Chourabi, et al. [7] noted, the problems seem limitless and include "…waste management, scarcity of resources, air pollution, human health concerns, traffic congestion, and inadequate, deteriorating and aging infrastructures." The problems have been perceived as highly complex, and involve organizational, technical, physical or material requirements.

The problems appear to be pervasive in cities around the world. As URBACT outcomes demonstrate, the European cities are "…not sustainable, inclusive or productive enough for the modern age." [8] We have previously argued that more innovative solutions to technical and integration problems are needed, and that the key focus should be on preventing Smart solutions from creating more or exacerbating current problems. The technical complexities, scope, and effort needed to implement new solutions requires a technically driven design composed of standards that can support new initiatives, services, and legacy systems with all associated data, and processing. [9] Historically, these have been difficult if not impossible objectives to reach when framed by traditional fractured and proprietary technology systems development approaches encumbered with traditionally long development cycles and large, expensive, and politically charged management decision structures which leave little room for change and no methods for resolving any external dependencies to complete implementation. We have previously noted that by establishing a marketplace of trusted foundational services based upon policies that ensure transparency and participation, Smart City objectives can be achieved and sustained to deliver a marketplace driven system that enables service discovery and effective service combinations. [9]

The technology concern is apparent in many solution designs. In their summarizing paper Chourabi, et. al. [7:2289] identify both important trends and suggest research agendas about cities that may become "Smart." One of the challenges extensively discussed in the literature as a potential success factor, and a core component in all four definitions of a Smart City, is data. A Smart City uses data to; monitor and integrate its critical infrastructures with IT [9]; connects IT infrastructures that leverage intelligence [10]; combines ICT and Web 2.0 technology with other organizational, design and planning work [10]; and employs computing technologies to make the critical infrastructure more intelligent, interconnected, and efficient. [12].

Harrison et al.'s study [10] emphasizes that a Smart City is highly interconnected, including the capture and integration of live real-world data including "…sensors, kiosks, meters, personal devices, appliances, cameras, smart phones, implanted medical devices, the web, other similar data-acquisition systems, including social networks [acting] as networks of human sensors." Chourabi, et. al. [7:2290] note that interconnection means the integration of data into an enterprise computing platform and the communication of such information among the various city services. Intelligence refers to the inclusion of complex analytics, modeling, optimization, and visualization in the operational business processes to make better operational decisions. Washburn et al. [12] view a Smart City as a collection of smart computing technologies applied to critical infrastructure components and services. Smart computing refers to a new generation of integrated hardware, software, and network technologies that provide IT systems and real-time awareness of the real-world and advanced analytics, and actions that optimize business processes. Chourabi, et. al. [7:2290] The many definitions of a Smart City caused Chourabi et al. to offer eight factors that could impact "… the design, implementation, and use of Smart Cities initiatives." Five of the eight success strategies proposed by Chourabi, et. al. [7] involve descriptions of information systems and applications of technology. Chourabi, et. al.'s review of the literature also supports this, noting that Smart City IT initiatives and projects have highlighted these issues as important success factors or major challenges.

The key point made in many of these definitional statements is that many directly involve or depend upon information systems, interconnection, and data integration. The Smart City necessitates operational success based upon highly effective digital communication, embedded intelligence, sensors, tags, and software. [9].

2.1 A Program for Smart City Technical Regulation and Guidance

We consider a group of related projects managed in a coordinated way (while obtaining benefits and control not available from managing them individually) to be the cornerstone of our Smart City technical program definition. [13] Thus, a program may encompass many unique individual projects with each delivering a complete or a subset of a specific function. Program managers or leaders consider the overall context for a number of related projects, manage a number of or portfolio of projects, involve politics and negotiating among competing goals and objectives, appear to be more strategic in their orientation, and deal with maximizing Return on Investment (ROI). [13]

We adopt this model to manage the Smart City technical governance and decision making effort where program and portfolio management are viewed as activities that are an important linchpin in a larger formalized Smart City effort necessary for project governance, coordination and management. It is critical for the program office to set portfolio direction (for the many projects), assess the effectiveness and

efficiency of the project, and to provide open disclosure and reporting on the portfolio.

The Smart City program office needs to implement the high-level governance functions described in this paper for two reasons. First, it must account for the interconnectedness and dependencies among of the various technical projects and their individual objectives in order ensure that projects meet their objectives and deliver the required outcomes. Second, the program office must focus on optimizing (where possible) the interrelationships among the management requirements, sharing of project resources, coordinating sequences of schedules and activities, monitoring quality processes, and or executing other integrative efforts.

2.2 City Powers and Governance

Legally, a city's authority to solve problems and control their future development with certain limited powers granted or delegated to them by state government. Thus, cities are viewed as "creatures of the state with limited and specifically defined roles and responsibilities". [14, 15] The legality of this state control model has been reviewed in a number of cases. If there is a reasonable doubt if a power has been granted, the power has not been granted. [16]

So what can cities do to solve the technical problems identified, legally, operationally, and from a perspective of the desired action being "good" from the city's perspective? Functionally, a city has the authority and the responsibility to develop, define, and implement programs that can provide the technical governance needed for Smart Cities. As an example, the laws from Texas show the power of cities to set technical standards needed to manage technology are granted to cities. In this state (Texas), cities have the power to have police act to regulate and promote the general welfare of the city's residents. It is covers many typical ordinances such as those maintaining order, controlling noise and disturbances, regulating public nuisances, and implementing regulations that necessary for health and suppressing diseases. A city can enact zoning ordinances, implement a city plan, regulate roads, and construct, and maintain facilities for public use. [16].

The exercising of city power has dual benefits, in addition to promoting a position that provides technical guidance; the city is not then susceptible to new leaders, or officials being swayed by salespersons who may convince a specific department of the unique value of a product that is not in the long-term interest and goals of the city's plans. The Return on Investment from adopting technical standards can eventually have the same impact current city plans and standards have with power, roads, building codes, and licensing. The city strategy would be to develop and provide smart solution vendors guidance prior to technical bids that informs them of the Smart City plan including enterprise portfolio governance, guiding principles, and architectural constructs, quality controls and standards that must be adopted and enforced. This could include; implementing transparent reporting during development via milestone reviews, conducting city run testing before project completion or release, and including telemetry during their solutions operations.

The standardization bodies, and the limited standards "available" for adoption as well as the limitations of those current utilized have been identified in other research. [17] Standardization bodies that address Smart cities directly include: the International Telecommunications Union (ITU), International Standards Organization (ISO), National Institute of Standards (NIST, USA) , European standards organization, (CENCELENEC/ETSI) , British Standards Institute (BSI) , and Spanish Standards (AENOR). Anthopoulos and Giannakidis [17] have identified and analyzed the standards and described them as an "open race," where smart service and policy making have been omitted. The data also suggest that the standards are not truly accepted by all countries, and bodies, and that obvious competing companies with international presence will have some difficulty implementing these efficiently.

2.3 Defining Technical Governance and Guidance

It is worthwhile noting that researchers and proponents of Smart Cities have previously agreed that technical guidance, and standards to ensure integration, interoperability and implementation successes are important to the overall success of Smart Cities. It is instructive that only a small amount of effort has been directed to providing explicit guidance to identify, define, and provide examples of the characteristics that must be provided to vendors of systems and components. This call for additional, actionable guidance has been discussed in varying contexts apart from documents or governance instruments that would state this is what must be done. A study that identified the importance of establishing technical governance for a Smart City by Johnston and Hansen [9] described the need to implement smart governance processes with constituents who exchange information in accordance with rules and standards. Odendaal's [18] case study found smart governance promotes collaboration, data exchange, service integration and communication, and meets the goals of the technical governance deemed important. However, neither specified how this technical exchanged would occur, or provided detailed service and integration guidance. Giffinger et al.'s [1] ranking model to assess European mid-sized Smart Cities viewed smart governance as a core component of Smart Cities, but within their model, smart governance was represented by inputs from citizen participation and more transparent processes, and not technical guidance. Lastly, Scholl et al. [19] identified stakeholder relations as one of critical governance factors needed to determine the success or failure of e-government projects. The "stakeholder relations" factor described in this paper emphasizes cooperation and data exchanges including the ability to cooperate among stakeholders, support of leadership, structure of alliances, and working under different jurisdictions. However, it does not define the components of the technical regulatory environment needed to ensure that such alliances, communication, and technical coordination will occur for successful programs.

In the next section, this paper offers a beginning point for establishing Smart City technical governance, policies, and regulations similar to existing governance, policies, and regulations used by many cities in the form of building codes, land development regulations, interfaces for public services, roads, and a large number of services and functions provided for the health and safety of the general public. These concepts follow the common regulatory guidance previously identified as both a delegated authority, and as an accepted responsibility of cities and other local government entities. The elected public officials, managers, and staff for each Smart City must provide the appropriate regulatory mandates prior to implementing

Smart City solutions. Consider published building codes. In most cities, these codes been developed over many years as buildings have changed, materials have evolved, environmental limitations have become known, and citizen requirements advanced. They provide for some assistance and even protection from commercial entities that did not perform as promised or were not readily manageable without professional expertise and standards.

3 Research Methodology

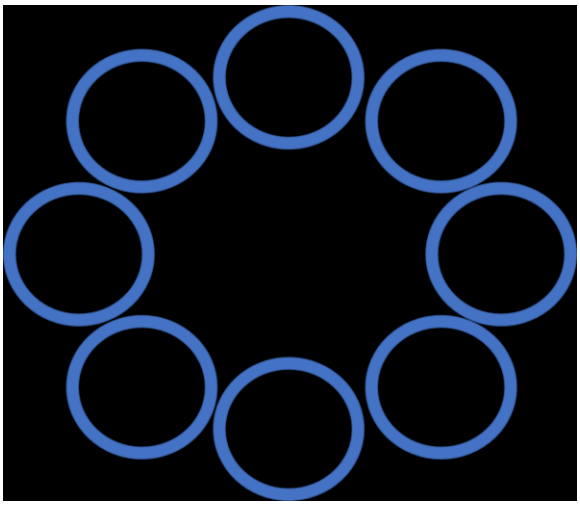
Observations across multiple large successful software systems identified common components including; system to system and system to subsystem environmental stability, meeting administrative and end user requirements, gracefully coping with errors, and assurance of operational monitoring and user safety while clearly identifying liability. These commonalities are generally implemented above the delivery program but below common oversight activities. Smart City initiatives provide an opportunity to implement these lessons learned. Specifically, Smart City governance must lead Smart City projects with city-wide initiatives that will ensure the resulting Smart City software doesn't live in isolation, but operates without impacting other Smart City solutions.

Successful Smart Cities will address and/or provide:

- **Environmental Interactivity** - via a common platform to enable complete Smart City solutions, solution components, and independent services including automation for agents and bots as well as registration and tracking active components.
- **Citizen Requirements** -via a collaborative mechanism to track requirements and issues that allows all participants in the Smart City ecosystem to participate. Additionally, Smart Cities need to tag and track core and critical services in near real time allowing for dynamic combination and adoption of certified service components.
- **Error handling** - handling errors and anomalies in running processes largely at no cost (except processing time) to participating service and solution providers. Errors are first detected by the running solutions, then the automated host system, and lastly by the users. Subsystems sequentially handle Severity 1 issues (causing a full system outage, to be isolated and abandoned); Severity 2 issues (causing a partial loss of system services, are retried, reported, and immediate remediation taken); and Severity 3 issues (non-critical errors resulting in degraded system performance or unexpected behaviors, reported without interruption in service); Severity 4 issues (with no impact the quality of the running solution but would improve user experience, are submitted to queue for future execution).
- **Safety Guidelines, Operational Monitoring, and Issue Liability** - will provide continuous monitoring of the host environments, the platform, and the services including telemetry to be assessed in near real time to assure a consistent, safe experience. Prior to deployment any solution or service needs to negotiate liability for any part it may have in system health or operational safety concerns.

This current focus on point solutions needs to evolve into a fully integrated set of city managed services. In a recent report by the Center for City Solutions National League of Cities, Brooks Rainwater et al. stated, "Cities are focused on these [specific] goals right now, and they are beginning to think about how these systems can be integrated to create feedback loops that improve operations and enhance the experience of community members". [20] He goes on to say "While ICT infrastructure makes the technological aspects of smart development easier, the organizational components remain challenging. Cities should work to lay the groundwork for smart development. Establishing the necessary policies (such as open data and e-governance policies) and administrative capacity (for example, a department for innovation and technology) in advance will better position cities to take advantage of these new technologies."[20] Established standards are intended to be a mandatory minimum requirement for all participating parties in Smart City implementations as described by the National Institute for Science and Technology in their 'IoT-Enabled Smart City Framework' [20].

Chourabi et al. [7] believe there are eight categories in a Smart City framework including technology, management and organization, policy, governance, people and communities, economy, built infrastructure, and natural environment. [7] While all are important our recommendations below focus on the immediate need to expand on and further define the policy and governance categories. To that end we believe there are 8 detailed areas for implementation;



Location - Objects, people, and events have a current and historical physical locations. Zlatanova noted "...The generic idea of GISs is to incorporate geometric and semantic information in one system and to support analysis [across] domains, …" [21] All objects must include GIS references including shapes, relationships (shared edge/vertices), and relative point locations (lat/long).

- **Taxonomy** - All literatures discussed consistent taxonomies, but none provided a working model. A New Taxonomy of Smart City Projects, [22] identified a limited taxonomy for objectives, tools, and stakeholders, but is not adequate for use in the correlations of described in Context below of objects, relationships, location and temporal components.
- **Context** - Context is "...any information that can be used to characterize the situation of entities (i.e. whether a person, place or object) that are considered relevant to the

interaction between a user and an application, including the user and the application themselves." [23] Context allows the Smart City platform to differentiate data from information.

- **Transparency** - Transparency promotes accountability and provides information for citizens about what their Government is doing." [24] The Smart City platform needs to ensure all services are reported, audited, logs are managed and available, and security is applied without causing legitimate access issues.
- **Portfolio** – Smart Cities need to maintain 3 separate assets portfolios including an enterprise portfolio of operating, in development, and proposed projects mapped to achieving city or citizen outcomes; a enterprise portfolio of standards and practices; and a portfolio of solutions, components, and services that are certified, being certified, or candidates for certification.
- **Credibility –** Smart Cities will need to allow multiple sources to provide similar if not identical datasets and services including the provenance of all city hosted components based on its history, availability, user ratings, and other city defined criteria.
- **Availability –**Smart Cities consumers require trust, and transparency of services achieved through high utility level reliability. Ideally the Smart City platform would provide s system average interruption frequency index (SAIFI), a customer average interruption duration index (CAIDI), and a system average interruption duration index (SAIDI), as defined by the IEEE Distribution Reliability Working Group [25]
- **Hosting –** Smart Cities need to provide flexible hosting infrastructure capable of supporting multiple tenant models, low latency communications, and elastic scale.

4 CONCLUSION AND FUTURE THOUGHTS

This paper posits that a great preponderance of available articles and Smart Cities research studies address technical projects with a more singular focus. The project are often demonstrations or effort to achieve experimental goals. They may discuss the laudable objectives of Smart City policy and stakeholder decisions but often omit specific technical information requirements, standards, or examples of wide and coordinated Smart City actions and success.

This paper fills this research gap by introducing a first view of the technical requirements for constructing a comprehensive framework to establish the Smart City projects by leveraging functional innovations comprised of technology, governance and , management and policy as a part of a coordinated urban service delivery solution. Following the thoughts and presentation of Chourabi et al. [7], we utilize the eight related categories in a Smart City framework that includes technology, management and organization, policy, governance, people and communities, economy, built infrastructure, and natural environment to frame our technology governance recommendation. [6] All eight categories are important, but this paper focuse7on the immediate need to expand on and further define the technology policy and governance categories. To that end we have described and discussed the 8 detailed areas for implementation; Location, Taxonomy, Context, Transparency, Portfolio, Credibility, Availability and Hosting. We believe these are the minimal mandatory standards to be met by all participating parties in a given Smart City implementation. They enable each new capability to be acquired and added to the existing infrastructure with a minimum of tailoring and reworking of existing component interfaces. When implemented they will provide a consistent safe reliable infrastructure that serves the citizen while opening up an ecosystem of micro services, reducing time needed to delivery services, and enabling the Smart City to plan, design, and implement future projects meeting governance and technical standards. They are necessary to promote the ecosystem of micro services, speed up the delivery and implementation of truly beneficial city-wide integrated services, and establish a beginning point for the architecture of future smart projects meeting the governance technical standards discussed in this paper.

We urge Smart City community leaders (who may at this point be self-defined) to come together, as the seventeen original Agile Manifesto authors did in February of 2001 and develop a Smart City Manifesto for city and community users. We recommend that Smart Cities attempt to take a page from Agile history and establish community values that are important to and trusted by Smart City stakeholders, and by those who live and work in the city environments. Such a manifesto might help all cooperatively uncovering better ways of initiating Smart City projects that can be more readily obtained from a Smart city marketplace.

Agile (26) went on to develop twelve guiding practices to support teams in implementing and executing software and systems. The goal of these principles was clear – to complete and finish systems that accomplished user objects and fulfilled the requirements. We believe that Smart City projects would be well served to address and formally profess similar guiding objectives and practices. Finally, we would hope that in the end resulting Smart City manifesto might incorporate setting, implementing, and following control and management principles that respect the importance of a technical regulatory environment within a Smart –wide technical architecture as we have described.

5. REFERENCES

[1] Giffinger, R., Fertner, C., Kramar, H., Kalasek, R., Pichler-Milanovic, N., & Meijers, E. (2007). Smart cities. Ranking of European medium-sized cities, Final Report, Centre of Regional Science, Vienna UT.

[2] The White House. FACT SHEET: Administration Announces New "Smart Cities" Initiative to Help Communities Tackle Local Challenges and Improve City Services. Office of the Press Secretary, (September 14, 2015).

[3] President's Council of Advisors on Science and Technology. Technology and the Future of Cities. Washington, DC, February, 2016.

[4] Nam, T., & Pardo, T. A. (2011, September). Smart city as urban innovation: Focusing on management, policy, and context. In Proceedings of the 5th International Conference on Theory and Practice of Electronic Governance (pp. 185-194). ACM.

[5] Rayal, F. 5 Reasons Why Smart Cities Fail. SMART CITIES STRATEGY. JUNE 06, 2016.

http://www.smartresilient.com/5-reasons-why-smart-cities-fail

[6] Buyya, R., Yeo, C. S., Venugopal, S., Broberg, J., & Brandic, I. (2009). Cloud computing and emerging IT platforms: Vision, hype, and reality for delivering computing as the 5th utility. Future Generation computer systems, 25(6), 599-616.

[7] Chourabi, H., Nam, T., Walker, S., Gil-Garcia, J. R., Mellouli, S., Nahon, K., Pardo, T. A., Scholl, H. J.: Understanding Smart City Initiatives: An Integrative and Comprehensive Theoretical Framework. In: Proceedings of the 45th Hawaii International Conference on System Sciences, pp. 2289-2297 (2012)

[8] Smart Cities Citizen Innovation in Smart Cities, Baseline Study. URBACT II. June 2012. ww.urbact.eu

[9] Money, W. H., & Cohen, S. (2015). Developing a Marketplace for Smart Cities Foundational Services with Policy and Trust. International Journal of Computer Science: Theory and Application, 3(1), 1-12.

[10] Harrison, C., Eckman, B., Hamilton, R., Hartswick, P., Kalagnanam, J., Paraszczak, J., & Williams, P. (2010). Foundations for Smarter Cities. IBM Journal of Research and Development, 54(4).

[11] Toppeta, D. (2010). The Smart City Vision: How Innovation and ICT Can Build Smart, "Livable", Sustainable Cities. The Innovation Knowledge Foundation. Available from http://www.thinkinnovation.org/file/research/23/en/Toppeta_Report_005_2010.pdf.

[12] Washburn, D., Sindhu, U., Balaouras, S., Dines, R. A., Hayes, N. M., & Nelson, L. E. (2010). Helping CIOs Understand "Smart City" Initiatives: Defining the Smart City, Its Drivers, and the Role of the CIO. Cambridge, MA: Forrester Research, Inc. Available from http://public.dhe.ibm.com/partnerworld/pub/smb/smarterplanet/forr_help_cios_und_smart_city_initiatives.pdf.

[13] Rose, K. H. (2013). A Guide to the Project Management Body of Knowledge (PMBOK® Guide)—Fifth Edition. Project Management Journal, 44(3), e1-e1.

[16] Frug, G. E. (1984). The city as a legal concept. In Cities of the Mind (pp. 233-290). Springer US.

[15] http://www.governing.com/columns/urban-notebook/Creatures-State.html

[16] Texas Municipal League. Powers and Duties of Cities. Austin: TML. http://www.tml.org/Handbook-M&C/Chapter4.pdf Last accessed January 5 2017.

[17] Anthopoulos, L., & Giannakidis, G. (2016, November). Task-based process modeling for policy making in smart cities. In ITU Kaleidoscope: ICTs for a Sustainable World (ITU WT), 2016 (pp. 1-8). IEEE.

[18] Odendaal, N. (2003). Information and communication technology and local governance: understanding the difference between cities in developed and emerging economies. Computers, Environment and Urban Systems, 27(6), 585-607.

[19] Scholl, H. J., Barzilai-Nahon, K., Ahn, J-H., Olga, P., & Barbara, R. (2009). E-commerce and e-government: How do they compare? What can they learn from each other?. Proceedings of the 42nd Hawaiian International Conference on System Sciences (HICSS 2009), Koloa, Hawaii, January 4-7.

[20] Nicole DuPuis and Elias Stahl, 2016. Trends in Smart City Development, National League of Cities, Center for City Solutions http://www.nlc.org/Documents/Find%20City%20Solutions/Research%20Innovation/Smart%20Cities/Trends%20in%20Smart%20City%20Development.pdf

[21] Zlatanova, S., 1999. 3D GIS for urban development. PhD. Thesis.http://www.gdmc.nl/zlatanova/PhDThesis/html/content. html (accessed January 2004).

[22] 17th Meeting of the EURO Working Group on Transportation, EWGT2014, 2-4 July 2014, Sevilla, Spain New Taxonomy of Smart City Projects

Guido Perbolia,b,*, Alberto De Marcoc, Francesca Perfettia, Matteo Maroned

[23] Dey A. K. & Abowd, G. D. (2000a). Towards a better understanding of context and contextawareness. Proceedings of the Workshop on the What, Who, Where, When and How of Context-Awareness, affiliated with the CHI 2000 Conference on Human Factors in Computer Systems, New York, NY: ACM Press

[24] The White house, Transparency and Open Government, Memorandum for the Heads of Executive Departments and Agencies; https://www.whitehouse.gov/the_press_office/TransparencyandOpenGovernment

[25] John MCDANIEL, Werner FRIEDL, Heide CASWELL, 2015 BENCHMARKING OF RELIABILITY: NORTH AMERICAN AND EUROPEAN EXPERIENCE, 23rd International Conference on Electricity Distribution

[26] Agile. https://www.agilealliance.org/agile101/12-principles-behind-the-agile-manifesto/ Last accessed, January 6, 2017.