

Urban Enterprise: a review of Smart City frameworks from an Enterprise Architecture perspective

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Abstract — With the increasing interest towards the concept of Smart Cities from the city governments world-wide there is a need for useful and Information Systems oriented approach to understand Smart City propositions. In this paper we review a Smart City from an Enterprise Architecture (EA) perspective. We adapt TOGAF Architecture Development Method (ADM) to derive the concept of Enterprise Concerns. These concerns will subsequently be used to review the Smart City literature. Finally, we summarize our findings and propose the concept of the Urban Enterprise composed of Urban Enterprise Components.

Keywords—*Smart City; Enterprise Architecture; Enterprise Concerns; Urban Enterprise; Urban Enterprise Components;*

I. INTRODUCTION

With the rapid developments in Information and Communication Technologies (ICT) industry, ICT became widely applied in different areas of human activity including cities. The high application of ICT to the city environment, and the identified benefits that technology can bring to the urban society, resulted in a numerous definitions of a city such as Wired Cities, Cyber Cities, Digital Cities, Intelligent Cities, and Smart Cities [16]. In this research we focus on the concept of a Smart City as it appears to be the dominant on the agenda of cities as well as scientific community.

Smart City is a world-wide trending phenomenon. However, there is no agreed definition of the term [3,17,23,27, 29]. Academic literature mostly view a Smart City as an ICT enabled development, and attempts were made to conceptualize a Smart City in terms of domains [23], functional requirements [15], dimensions [17, 20], areas of activity [5] etc. However we are still to see a model to unify all current perspectives, one model that could bring together the different Smart City concepts. We approach this problem by viewing a Smart City as an entity from the enterprise perspective. To do so, we borrowed the concept of enterprise from an Enterprise Architecture (EA) discipline [18]. Enterprise is defined as “any collection of organizations that has a common set of goals” [26]. We found the concept of an enterprise to be applicable to a Smart City for a number of reasons. First is that a Smart City in essence is a collection of different initiatives and organizations. Second is that those organizations, just like an enterprise, eventually have common goals such as improving quality of life for the citizens. Lastly, in the same way as the

competition between enterprises exists, there is competition between cities as well [10,12,14]. Although the scientific literature to-date regarding a Smart City contributes hugely to understanding of a Smart City concept, and propositions to use enterprise concepts such as Business Process Change (BPC) and Enterprise Systems Integration (ESI) exist in the literature [14], the identification of different components within a Smart City from the perspective of an enterprise is non-existent. For this reason we found it necessary to do the literature review of a Smart City frameworks and architecture propositions to identify elements that comprise a Smart City as an enterprise. This is a preliminary work and further testing through practical implementation is planned as a next step. The paper is structured in the following way: in Section 2 we explore EA concepts that we use for this research. In Section 3 we review the literature according to the concepts we have selected and we demonstrate our findings. In Section 4 we put together our findings to conceptualize the Urban Enterprise composed of Urban Enterprise Components which were identified during the literature review.

II. RESEARCH APPROACH

For this research we use well-established EA concepts from The Open Group Architecture Framework (TOGAF), proposed by The Open Group [26], specifically for the reason of it being an established industry standard which is developed by the consortium of companies. TOGAF utilizes latest and frequently used practices in the EA discipline.

The Smart City literature review was performed by searching articles that describe solutions and concepts for a Smart City. The criteria for selecting the article included the Smart City, Smart City architecture, and Smart City framework, either in the title of the document or the keywords. Also, the articles that in general conceptualized the Smart City and proposed some form of scope, boundaries or solution for the concept were selected. The number of citations and first occurrence in the search result were also one of the criteria for selecting the paper for review. In total eighteen articles were selected for the review.

III. ENTERPRISE ARCHITECTURE AND ENTERPRISE CONCERNS

A Smart City is a complex concept that is addressed by the academic literature from different points of view, and to date

the term Smart City is not clearly defined and is known to be ambiguous [3,17,23,27,29]. Numerous Smart City definitions exist however in this paper we will not discuss these. Instead, we propose an alternative view on Smart Cities which can be used to analyze smart city propositions within a scope of an enterprise.

The Open Group [26] defines enterprise as “any collection of organizations that has a common set of goals” with examples of enterprise types being “government agency, a whole corporation, a division of a corporation, a single department”. We examine Smart City as an enterprise having a defined set of goals and composed of various interrelated entities. As it matures, an enterprise can become a complex construct, especially in terms of its Information Technology (IT) systems. To tackle complexity the EA discipline [19] is practiced by organizations to address issues such as enterprise agility, core capabilities, and ability to react to change [25]. Also, the business IT alignment [16,28] facilitates transformation and is considered to be a core value of the EA. Knowing that a Smart City is primarily ICT enabled development, and that EA is positioned to address complexity of IT systems in a business environment, we find EA to be greatly relevant to the Smart City. In an enterprise environment IT systems are developed gradually. Smart Cities are also said to follow the same pattern [5]. As a Smart City increases maturity it will require the integration of all of its IT systems [7,20].

We use TOGAF Architecture Development Method (ADM) [26] as it provides a comprehensive methodology for designing Enterprise Architectures. ADM solves two main concerns in the EA development by 1) clearly defining the areas that need to be addressed, and 2) defining a sequence in which those areas are to be addressed. Knowing this, we find ADM to be applicable to the analysis of different aspects described in the Smart City literature for two reasons.

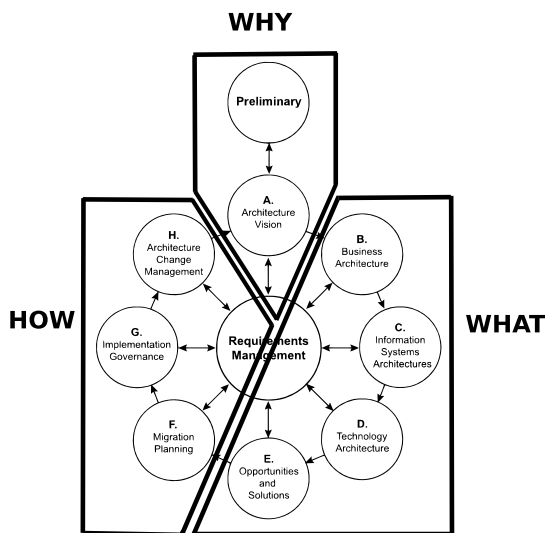


Figure 1: Enterprise Concerns as addressed by the TOGAF ADM. Adapted from The Open Group [26].

First is that ADM can be broken down into three general areas of concern that it addresses, and they can be expressed in questions of ‘Why’, ‘What’, and ‘How’, Fig. 1. These three areas of concern give a good basis for the classification of different aspects addressed by the Smart City literature. We conceptualize that these areas of concern can be applied not only to the architecture development, but also to the enterprise development in general with every enterprise continuously, either explicitly or implicitly, going through this set of concerns to survive and thrive. We call these the Enterprise Concerns. The Preliminary phase and Architecture Vision phase of the ADM broadly speaking give a reason for the architecture cycle, and therefore raise the question of ‘Why’ the architecture need to be developed. The further four ADM phases namely Business Architecture, Information Systems (IS) Architecture, Technology Architecture, Opportunities and Solutions identify ‘What’ needs to be considered in the architecture cycle. Lastly, the phases of Migration Planning, Implementation Governance and Architecture Change Management describe ‘How’ enterprise architecture needs to be handled.

Second reason is that ADM, which describes a process for an enterprise architecture development, could in the same way, potentially, be used to prescribe the development process for a Smart City. This second aspect is outside the scope of this work and can be addressed as a separate research undertaking.

IV. SMART CITY AND ENTERPRISE CONCERNS

As noted already, due to the ambiguity and lack of a unified Smart City definition [3,17,23,27,29] it was difficult to tell what a Smart City really is. However there is a common pattern across the articles that a Smart City is an Information and Communication Technologies (ICT) enabled development which extensively uses information as a way to improve quality of life for its citizens and population at large. It was obvious that all the literature reviewed present a Smart City as an entity that requires addressing many areas of its operations. Every Smart City proposal trying to solve the problem of a “city”, when in fact solutions often address one or a number of aspects of a Smart City. By doing so however, there is often no given explanation or a context regarding what other aspects of a Smart City the solution is affecting, or is interacting with. Some authors go into depth of certain topics, while others just touch on the topics by merely mentioning them. This makes the whole concept of a Smart City difficult to grasp and understand. In fact this has been criticized by calling Smart City solutions as “canonical examples and one-size fits all” [16].

We classified Smart City literature according to the enterprise concerns and identified a number of areas that the Smart City literature addresses, Table 1. Some of the reviewed literature addressed a very high-level, conceptual nature, of a Smart City such as characteristics and factors [10] the purpose of which is to make Smart Cities comparable to one another in terms of their performance. Strategic directions [21], application domains [29], soft domains and considerations for impact [23], propose high-level domains and sub-domains of a Smart City and give a scope for a more specific areas to be addressed. Strategic drivers that the Smart Cities should aim

for, such as innovation [22], were also found. We break these into three conceptual areas of purpose, scope, and goals. The high-level aspirational intent statements such as Smart Living, for example, are classified as purpose as they represent the ultimate desirable state in a Smart City. Within Smart Living, there are a number of elements that by themselves define a particular scope that needs to be addressed such as Entertainment, Pollution, Healthcare etc. [23]. Each of the areas with the scope then have numerous goals that need to be identified and articulated. These three areas of purpose, scope, and goals must be explicitly defined and addressed in their own right, especially knowing that competition between cities exist [10,12,14]. These areas can be considered as strategic, outwards and future looking, as they address the high-level aspirations of a Smart City and answer the question ‘Why’ the Smart City needs to be developed.

TABLE 1: ENTERPRISE CONCERNS ADDRESSED BY SMART CITY LITERATURE

Author	Enterprise Concerns		
	Why	What	How
[1]		Systems	Architecture Principles
[2]		Systems	Architecture
[3]		Stakeholders	Principles
[4]		Frameworks	Methodology
[5]		Stakeholders Systems	
[6]		Stakeholders Systems Frameworks	
[8]		Systems	Architecture
[9]		Systems	Architecture
[10]	Purpose Scope		
[12]		Systems	
[13]		Systems	Architecture Principles
[15]			Architecture
[21]	Purpose		
[22]	Goals	Methodology	Methodology
[23]	Purpose Scope	Systems	
[24]		Systems	Architecture
[25]			Architecture
[29]	Purpose Scope Goals		

Some of the literature focused on addressing the tangible aspects of a Smart City such as infrastructure [1,2,5,24], hard domains [23], web-accessible services [8] and information systems [9,12,13,24] all of which for the simplification

reasons we classify as systems. Also, frameworks and stakeholder relations were often mentioned [3,4,5,6,21] which we consider to be two distinct areas in their own right. All these aspects describe an inward looking perspective and answer the question of ‘What’ is needed for the Smart City to succeed.

The next set of topics were the actionable, behavior, and planning related aspects of a Smart City that address the question of ‘How’ the Smart City should be developed. This is where aspects of architecture [1,2,8,9,13,15,24,27], processes [22], and methodology [4] were discussed. We consider methodology to imply processes, therefore for simplification reasons we classify process as belonging to the methodology. Principles [1,3,13] were only lightly touched upon. However knowing that principles form foundations for understanding and cooperation within an enterprise between different stakeholders [11], and given the perspective that Smart City is potentially complex enterprise with cooperation between various types of stakeholders, we decided to include principles as a category on its own.

By generalizing the ADM and applying enterprise concept on a Smart City enabled us to view a Smart City from the perspective of an enterprise concerns giving it a high-level context. The Smart City literature review gave a perspective on different areas of a Smart City addressed by the literature.

V. URBAN ENTERPRISE AND URBAN ENTERPRISE COMPONENTS

Our view on a Smart City through the enterprise concerns assisted us to structure areas addressed by the literature. The first enterprise concern on ‘Why’ does the enterprise need to exist is addressed by the Smart City literature in terms of purpose, scope and goals. The second enterprise concern on ‘What’ is needed for an enterprise to exist is addressed by the Smart City literature in terms of stakeholders, frameworks, and systems. These are similarly trying to define what is needed for a Smart City to exist. The last enterprise concern on ‘How’ the enterprise should act and behave is addressed by the Smart City literature in terms of principles, methodologies and architecture, which describe the ways of how a Smart City can be developed and operated.

We use our findings to expand on the enterprise concerns and conceptualize the Smart City as an Urban Enterprise composed of the Urban Enterprise Components, Table 2.

TABLE 2: ENTERPRISE CONCERNS AND URBAN ENTERPRISE COMPONENTS

Enterprise Concerns	Why	What	How
Urban Enterprise Components	Purpose	Stakeholders	Principles
	Scope	Frameworks	Methodologies
	Goals	Systems	Architecture

Conceptualizing a Smart City as an Urban Enterprise potentially brings benefit of easier understanding and analysis of the future Smart City propositions in the literature. Some authors, for example, suggest an architectural solution for a

Smart City. However, a proposition like this can be very confusing when not given a broader context, such that architecture will affect numerous stakeholders, or that it might be build using certain methodologies to achieve certain goals within a specific scope, etc. Or, where the stakeholders and the systems they are interested in are discussed, it might be important to understand and explicitly name the purpose those stakeholders are trying to address within the whole of Smart City, or the principles that drive their work ethics as in regards to other stakeholders. Smart City is a complex system with many areas of concern that cannot be defined by a single research, but instead must be composed of a number of research undertakings. In general, it is always important to understand a bigger picture and see different elements which any Smart City solution or a proposition will interact with. To simplify understanding of a Smart City concept, it can be seen as an entity in terms of an Urban Enterprise which is composed of Urban Enterprise Components that specify a number of areas which Smart City solutions can address.

VI. CONCLUSION AND FUTURE WORK

As discussed in this paper, a Smart City is a complex concept described in many academic literature from different perspectives and in various ways. There is no incorrect definition of a Smart City, as many are context specific. The problem with so many definitions however, is trying to understand what a Smart City really is. We view Smart City as an entity and compare it to the enterprise concerns which we derive from an Enterprise Architecture discipline. In our Smart City literature analysis we used Architecture Development Method (ADM) to identify different areas addressed by the Smart City literature. We then introduce the concept of an Urban Enterprise which enables to view a Smart City from the enterprise perspective. The Urban Enterprise is composed of a number of Urban Enterprise Components that can be separately looked at and analyzed. This potentially brings capability to analyze and understand the Smart City in terms of the numerous discretely defined components. The future work to continue this research should be to expand the literature review, and also to apply the concept of Urban Enterprise and Urban Enterprise Components in practice to see if they can be addressed in a process-like manner to develop a Smart City and conceptualize the Smart City development process. This could be tried and achieved in the following way. As ADM is an iterative and repeatable process [26], similarly the Smart City development process could be conceptualized having the same characteristics within the context of continuous Smart City development approach. As the questions ‘Why’, ‘What’, and ‘How’ in ADM are addressed in a sequential manner it can be assumed that addressing these questions in the same sequence while utilizing the Urban Enterprise Components, Table 2, could potentially prescribe the development process for a Smart City.

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