Smart people: enhancing CCD citizens' engagement through data utilization

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Abstract— Providing the ability of making the most out of the considerable amount of data that is going to be produced once Ciudad Creativa Digital (CCD) comes alive is the purpose of the Analytics and Visualization (AAV) group. After identifying the elements of the CCD data ecosystem we describe the building blocks of our strategy. We also present a measure of Citizen Engagement that encompasses relevant aspects of the Smart People dimension of the European Smart City Model and outlines a proposal for using Complex Event Processing (CEP) as part of the Data Management layer of the Urban Operating System of CCD. To support our approach we are leveraging the expertise generated by the Universidad Del Valle de México (UVM) SmartCampus, which will also function as a testbed to prove our concepts.

Index Terms— Smart Cities, Analytics, Visualization, Complex Event Processing

1 Introduction

THE significant endeavor of creating a hub for the digital media industry in Mexico, the Ciudad Creativa Digital (CCD) project, gives birth to several challenges that can be tackled with an efficient information strategy driven by well-designed analytical processes. The CCD master plan envisions the CCD as unique place to live and work [1] making relevant the understanding of the impact of such environment over the life of its citizens.

Having this goal in mind the Data Analytics and Visualization (AAV) group started an exercise of exploration about how data can be manipulated and represented in such a way to allow the extraction of meaningful insight in the context of CCD. In this paper we describe the data environment, set strategic guidelines for data management and sketch a proposal that, once tested on a more controllable environment, can escalate to cover the CCD.

Our approach leverages the European Smart Cities framework [2] to define a set of innovation opportunities to pave the way for the work to be done in the forthcoming months. From the set of six pillars that comprises the European Smart City model (ESCM) [2] we are focusing our attention on Smart People and from the set of factors that comprised this component we chose *Affinity to lifelong learning* and *Participation in public life*. Sections 2.3 and 3.1 describe in detail the rationale behind this decision. Our current scope taps into other areas of the ESCM such as Smart Governance (participation in decision-making) and Smart environment (efficient use of water and electricity). To consolidate all these factors we are proposing (a) a metric called Citizen Engagement and (b) a set of indicators that can be used to measure it.

According to the master plan, one of the CCD strategic guidelines is to design urban systems that respond to the needs of the city in real time [1]. This guideline is aligned to the objective of making CCD a showcase for integrating city services. Having this in mind, the AAV group is proposing the creation of a tool capable of providing this real-time feedback to its citizens. Our expectation is that by empowering citizens we will increase the Citizen Engagement metric. The core of this solution resides on a Complex Event Processing (CEP) engine that by finding patterns on the available data (previously cleansed and prepared) creates and promotes constructive and purposeful social interactions.

As this tool will be a consumer of the capabilities that will be provided by the CCD Urban Operating System (uOS), we propose that the CEP engine should be part of the Data Management layer in the uOS. As we want to construct our proposal with proven concepts, our plan is to develop a Proof of Concept in a familiar setup, the Universidad Del Valle de México (UVM) SmartCampus, and later escalate tested concepts and technologies to CCD.

It is important to say that, given that within the ESCM what makes a city smart is its ability to perform well in all six pillars, the scope of the work of the AAV group will be eventually extended to cover the rest of the areas.

2 Understanding the CCD data ecosystem

As CCD represents a rich data environment where the actors can greatly benefit from data access, we focus our analysis on the interaction between the existing data and its consumers, particularly on how this interaction improves the quality of life within CCD. These are the main actors in the CCD data ecosystem.

2.1 CCD data streams

The CCD data streams identified in the master plan are as follows: energy, water, mobility (e.g. public transportation and parking), waste (e.g. waste collection), fibre and telecoms (e.g. phone calls), security and street lighting, and streams generated by the creative industry and the

commercial section in CCD [1]. Instead of overwhelming a citizen with all this data, an analytic layer will provide the means to extract meaningful information for each individual (see section 4.1 for details).

2.2 Urban Operating System

Within CCD, data is created, managed and consumed by means of a large set of components distributed over several layers including a physical infrastructure, network capabilities and business processes. This is the Urban Operating System (uOS). This uOS supports a comprehensive set of digital services. Considering the uOS, the AAV group is focused on how real-time feedback can be provided to CCD citizens. Some of the relevant topics that we have identified in this area are related to (a) the specification of the devices that will be able to convey this information; (b) the nature of visual representations that will facilitate data comprehension; (c) the frequency of data pooling for reporting purposes; (d) the granularity of data and (e) how citizens can leverage uOS to make better decisions and execute them.

2.3 Smart people

The AAV group is focusing its attention on Smart People. The rationale behind this decision has three components (a) Smart People has been identified as critical for Smart Cities [2]: the generation of a collective intelligence constructed on top of promoting information sharing and collaboration; (b) Smart People represents a suitable domain for empirical treatment and experimentation where the effects of solutions can be measured at a low cost and (c) Smart People is aligned to the Official National Digital Strategy particularly to the *quality of education* axis [3]. Furthermore, evidence suggests citizen engagement is a fundamental factor in the successful implementation of Smart Cities in conjunction with the technological infrastructure [4] [5] [6]. The set of actors that comprises the Smart People universe within CCD includes families, workers, visitors, neighbors and entrepreneurs among others [1].

3 Guiding Principles for Analytics

Our directives for strategic planning (all of them aligned to the vision that gave birth to the CCD project) are as follows.

3.1 Narrow the analysis to Citizen Engagement

A citizen of CCD is self-decisive and aware. By conceptualizing CCD as a powerful community [10], we can assume that its citizens have a common purpose and an interest to act collectively. Also, given that the CCD defines a space where specialized knowledge is generated and used, an important component should be how citizens are accessing and producing this knowledge. Our definition of engagement is constructed on top of these assumptions.

It is important to define which type of engagement is going to be analyzed as different *engagement* types have different backgrounds and outcomes [7]. This means that we need to determine whether we want to measure the citizen in relation to the creative industry within CCD or the creative citizen in relation to CCD. We chose the latter approach where a CCD citizen generates and applies knowledge.

Engagement can be measured at three dimensions: (a) behavioral, based on the notion of participation and involvement in activities beyond a person's role within its group; (b) emotional, oriented to either positive or negative reactions towards other people and institutions; and (c) cognitive, which denotes the required effort to comprehend complex ideas or to gain specialized skills [7].

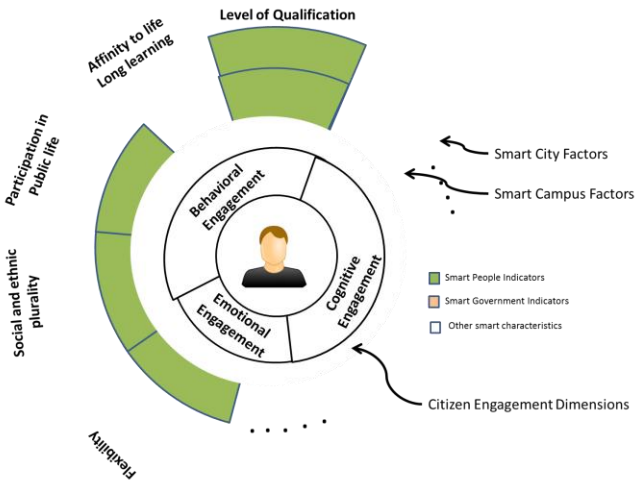

Figure 1. Engagement definition in relation to Smart City Characteristics

Table 1. Engagement Metrics

smartCity (CCD)	smartCampus (UVM)
Behavioral Engagement	
Compliance with traffic rules	Compliance with Campus Regulations
Care crosswalk	Concentration in Class
Incident report	Class Assistance
Internet usage per person (number of devices)	Internet usage per student/teacher/administrative staff member (number of devices)
Emotional Engagement	
Public services satisfaction per service	Affinity to teacher
Interaction between neighbors	Integration with classmates
Services satisfaction (e.g. restaurants)	Course content satisfaction and interest
Cognitive Engagement	
Ability to coordinate between neighbors to perform an action	Effort Control
	Use of learning strategy

	Retention capacity		proposal	formation
	Ability to interact between carriers to develop interdisciplinary projects		Number of participants involved in the polling	Application that will gather this information

Table 2 shows the indicators used in our *engagement* index. All measures are related either to access to learning resources or to participation on decision making activities within CCD.

Table 2. Smart People Data source-Indicator-Factor

Factor	Indicator	Data source?
UVM		
Affinity to lifelong learning	Understand readings	Moodle. Reading Activities. Retention capacity
		Moodle. Book Reading Activities. Summary quality
Participation in public life	Number of activities registered outside campus	Bike ride participation organized by UVM
		Reading books. Participation in the FIL
CCD		
Affinity to lifelong learning	Use of digital resources per resident per month	Number of read documents from the digital public library
	Number of course offerings by period	Number of online courses completed (provided by SEP)
	Number of alumnae registered to courses by period	Number of students registered in the online courses provided by SEP
	Number of feedback forms (to the institution or teacher) provided by course and period (infrastructure, classroom, courses)	Online survey sent at the end of the course before final exams
Participation in public life	Number of collective decisions made by period, and in the voting.	Application that will gather and process this information
	Number of participants involved in the	Application that will gather and process this in-

3.2 Focus on the Data Management Layer

Considering the topology of the uOS platform, we propose that the Data Management layer should have a CEP engine. We are also working on a set of initial services that can make use of this engine.

3.3 Test concepts in the UVM SmartCampus

The Universidad Del Valle de México (UVM) has a space where ideas can be tested: the SmartCampus. A SmartCampus is an entity that can involve Cloud computing, Internet of Things, intelligent components able to generate relevant information, but most importantly, it has the ability to consider all the systems involved as a whole [8].

There are several similarities between the relation of a student with his/her university and the relation between a citizen and his/her city. The UVM SmartCampus has found that the relation of students with the university is mediated by the students' objective: gaining knowledge, graduating, avoiding desertions. We can leverage this kind of insight to further understand CCD citizens.

3.3 Empowering Citizens

Together with facility management and efficient use of assets, making data available to individuals will generate the kind of interactions that should impact our *engagement* measures. We can define a variable for each of the engagement dimensions described in section 3.1 and, by providing the right services, impact the factors of interest in CCD. For instance, an increment in engagement will produce and increase both (a) the level of qualification and (b) the affinity to lifelong learning. The idea of empowering people is that the citizens themselves can propose and activate those strategies that they consider pertinent to CCD.

3.4 Promote interoperability

A paramount challenge in our approach is that in complex setups the different systems tend to be isolated. In the case of Guadalajara we have at least three independent entities: government, university and industry. In the case of UVM we have student services, marketing and academy.

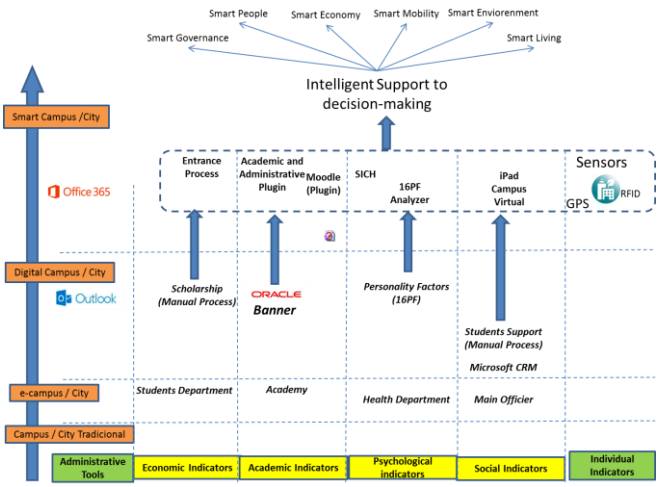

Figure 2. Roadmap to Smart Campus and Smart City

In order to mitigate this situation we propose a design that promotes interoperability in three different aspects:

- Operational Interoperability: the rich concept of an event can be used to describe data relations and business processes.
- Information interoperability: a single ontology is shared.
- Technical interoperability: there is a standard mechanism to register data providers and a single specification to define events based on open standards (XML, UML).

3.5 Align to priority digital services identified in the Master Plan

Sixty six services were identified during the creation of the master plan. These services were prioritized based on the number of people affected, the level lf importance and the lifetime cost [1]. One of the services identified as top priority is *Visualization and Digital display of information*. This service is focused on sustainability performance reporting. Access to this information can encourage behavioral change by increasing awareness. For this reason, we propose the development of a tool where data is no just consumed but also generated to increase engagement (see section 4.3).

4 A PROPOSAL TO INCREASE ENGAGEMENT

Now that the strategic guidelines have been described, we can construct a proposal to impact the *engagement* indicator.

4.1 The engine: complex event processing

We consider that Complex Event Processing (CEP) can be used to support the goals of the data management layer of the uOS platform particularly having in mind the goal of increasing citizen engagement. CEP is a structured framework where data streams can be coordinated. CEP has also the advantage of being aligned to business processes, which is another layer of uOS.

The goal is to have an Event-driven Smart City where smarteness is defined in terms of the ability of actors to handle events [9]. This framework provides a set of tools for citizens to make the most of CCD by providing intelligence and fostering collaboration.

An event is not just data but rather a product of an analytic process that provides added value to a set of raw data. Events can be created by following a standard structure that can be understood by all the actors (people, services, sensors and devices) because they all share the same knowledge.

Listeners can also be created to execute actions as a response to events. In this way the members of CCD can define pre-programmed actions in response to events created by them or can subscribe to events created by other users.

4.2 Architecture

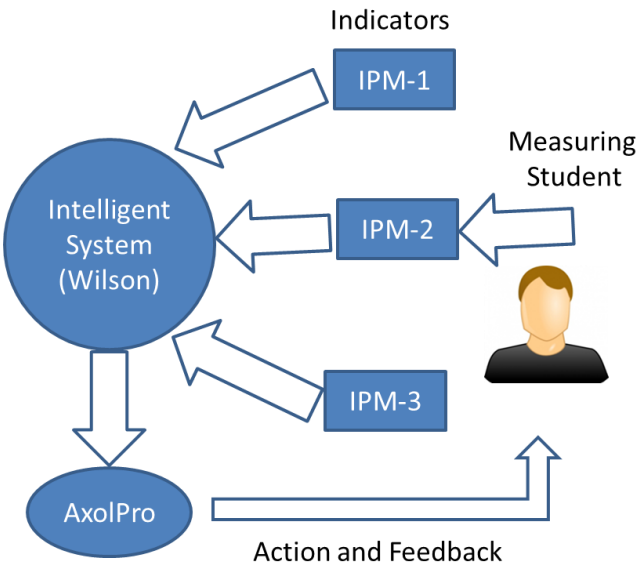

Figure 3. Architecture of SmartCampus UVM project

The solution is based on a layer of analytics composed by tables that provide an integrative view of data and a production system that captures facts about the world. The production system is filled with events. A central repository of rules is maintained with the listeners created by individuals. The production system fires rules and occasionally generates actions, which are processed by a different module. By correlating unrelated events, new facts can be discovered.

4.3 The tool: empowering Citizens

CCD can benefit from a tool capable of measuring and improving engagement. After defining a baseline is possible to test whether a tool that facilitates access to learning resources and promotes social decision-making is able to increase engagement. This tool has also access to the central repository of open information (and therefore consumes data generated from the sensors placed throughout the CCD). This information can be used by the citizens while emitting their vote or recommendation for the different polling activities occurring on CCD.

This tool can be conceptualized as a Crowd sourcing service where necessities and solutions are identified by the community of users. This tool is a lifestyle kind of service, focused on the social component according to the scheme of services defined in the master plan [1]. All the actors identified in section 2.3 can benefit by using this tool.
A key aspect of the functionality of this tool is its ability to capture rules. Figure 4 shows how rules are captured in the VirtualCampus system.

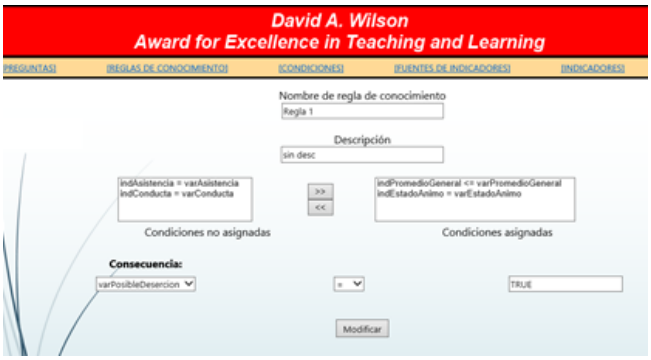

Figure 4. Capturing rules

4.4 Use cases

The aim of increasing Citizen Engagement defines a set of use cases where uOS becomes handy.
Examples of public life participation are as follows.

A) The members of CCD have access to the pattern of energy usage by using this tool or other means available in CCD (i.e. digital public displays). Citizens are subscribed to events that signal high energy consumptions.
B) Different proposals to reduce energy consumption are created by different citizens. These proposals are stored and made public by this tool. An event that signals the existence of proposals is created.
C) Proposals are further developed by citizens until they arrive to a final version. An event that signals the beginning of a voting process is created.
D) People votes for the proposals. An event signaling the elected proposals is created.
E) This tool can be used to create events that signal the success or failure of the actions agreed upon in the proposal.

5 Roadmap

Table 3 shows the roadmap. Activities are programmed for the next 9 months starting from April 2014.

Table 3. Roadmap of the Guadalajara's Metrics Definition.

	April	May	June	July	August	September	October	November	December
Define strategy									
Understand VirtualCampus									
Identify Data Sources									
Data Preparation									
CEP implementation									
Data modeling									
Generate visualizations									
Develop tool									
Deploy tool									
Evaluate tool									
Training									
Develop support plan									
Implement support plan									

1. Data understanding: identify which data sources are available and engage data owners.
2. Data preparation: complete a reconciliation process to unify data dimensions and definitions for all sources.
3. Data cleanse: prepare and represent data to allow the extraction of metrics and the definition of events.
4. Data modeling: creation of a base layer to store primary data and a package layer optimized for queries.
5. Implement production system to handle events.
6. Generate visualizations: deploy a suitable layout to enable users to make use of the information.
7. Evaluate solution.
8. Deploy solution.
9. Training and support.

6 Perspectives

The presence of a uOS within CCD will create suitable conditions for rich social interactions. In this framework we consider that the existence of a CEP layer and tools as the one proposed here will impact the lifestyle of citizens. Particularly engagement can be raised by encouraging participation.

We are working on defining the opportunities to leverage the experience obtained by initiatives such as UVM Virtual Campus.

Acknowledgment

The first author wishes to thank the Global Analytics division at Hewlett-Packard. The second author wishes to thank to UVM Laureate International Universities by all the provided support. The fourth author acknowledges the support provided by Asociacion Mexicana de Cultura A.C.

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