EPIC: A holistic approach for Smart City Services

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Abstract: Clouds have considerably changed the design and provisioning of modern ICT applications creating ecosystems of services that ease and simplify the related technical and business processes. However, the above mainly refers to the private sector with the solutions targeting the public sector and cities to be few and also limited in terms of capabilities and acceptance. In this paper we present an innovative solution based on a cloud platform that enables smart cities to realize their digital agendas. Our vision is the development of an "innovation ecosystem" that offers ample opportunities for sustainable, user-driven "intelligent services", by combining open innovation processes, advanced e-Government service applications and cloud computing technologies to create a truly scalable and flexible pan-European ecosystem for effective, user-driven public service delivery.

Keywords: Smart City, Clouds, Platform, Roadmap, Living Labs

1 Introduction

Nowadays several diverging definitions of a smart city exist which in general imply the use of modern ICT solutions such as the Internet of Things (IoT) and Web 2.0 to deliver more effective and efficient public services that improve citizens' everyday life, creating better city environments. The following definitions present different understandings of a smart city:

- **IBM**: Smart Cities digitise and connect infrastructures (IOT) to infuse them with new intelligence. Smarter cities make their systems instrumented, interconnected and intelligent [8].
- **MIT**: Networked intelligence in fabrication and construction (IOT) [9].
- **Forrester**: The combined use of software systems, server infrastructure, network infrastructure, and client devices, which Forrester calls Smart Computing technologies, to better connect seven critical city infrastructure components and services: city administration, education, healthcare, public safety, real estate, transportation, and utilities. [7].
- **University of Amsterdam**: The main focus of a smart city seems to be on the role of ICT infrastructure, although much research has also been carried out on the role of human capital/education, social and relational capital and environmental interest as important drivers of urban growth [6].

The key question that is posed here is: *"Is there a Need for a Cloud Platform for European Smart Cities?"*[2]. In this work, we present a novel solution for smart cities which was designed, implemented and validated in the frame of the EU Research Project EPIC [1]. The EPIC Project has created an innovative ecosystem of services, tools and policies, to support cities in their quest to become "smart(er)" and to implement their digital agenda. By developing a cloud platform for smart cities and a detailed roadmap as a guide, EPIC sought to provide an integral solution for realizing the smart city vision so as a) to benefit from the *innovative developments* of citizens, SMEs and other actors from across Europe rather than just within the city itself, b) to *leverage a service infrastructure* that is capable of delivering "one stop government" through the integration of services, interoperability of systems and use of actionable intelligence in service delivery, and c) to contribute to a *multi-national service-oriented ecosystem* by providing and sharing open business processes as services with other cities.

The EPIC Platform embraces innovative aspects to:

- provide a secure, scalable and cost-effective computing infrastructure for the deployment of smart city services using web-services and portlets;
- ensure interoperability with existing or new services and support for current and future devices by adopting open-standards;
- support fast and agile discovery, deployment and provisioning of "intelligent" services, reducing the "time to market" for service and applications developers;
- provide easy and secure access to information and services from the Public Sector and/or SMEs; and,
- provide the underpinnings for a smart city innovation eco-system supporting the SME ICT community.

By exploiting the EPIC approach, cities are facilitated to provide "intelligent" applications with an advanced set of technical, functional and business capabilities, based on the particular requirements of the city council, citizens and participating SMEs. These applications support partnerships between the public and private sectors as well as collaboration among cities. The applications deployed on the EPIC platform take the advantage of the platform services for scalability, sustainability and low operational cost which could readily be made available to a pan-European (and possibly, worldwide) market.

In addition, the EPIC Roadmap - as a complete guide and best practices handbook - has simplified the processes of extending existing applications and of defining and developing new smart services for cities, leveraging the involvement of enterprises and SMEs to create new business models and value networks [16].

EPIC combined open innovation methodologies exploiting a network of Living Labs, from the definition of the requirements to the validation of the outcomes through a number of closed and open testing cycles. All project developments were built around a set of *pilot applications* covering the following key aspects of a smart city: a) Relocation, b) Urban Planning and c) Smart Environment as well as an integrated proof of concept which combined elements of the pilot applications to compose an application that addresses effectively the specific needs of a "virgin", in terms of "smartness", city. This city was Tirgu Mures in Romania.

The document is structured as follows: Section 2 describes the methodology that has been followed for implementing the EPIC solution, which then is analysed in section 3. The experimentation process and results are presented in section 4, while section 5 highlights the added value of the proposed approach. Finally, section 6 concludes the paper.

2 The EPIC Methodology

Developing an environment for smart city services is a great challenge both from the technical and business perspectives. In that sense, starting from the definition and analysis of the user requirements we extended an existing one, the "Agile Development Methodology" [5] with Living Lab processes. According to this methodology, changes in the user requirements are welcome, even late in the development process, while updated versions of the software are being delivered frequently. Agile development process encourages close and daily cooperation between business people and developers. This means a numerous set of interactions between all partners, leading to the continuous definition of new requirements and the rapid delivery of useful working software.

Based on a series of workshops with the key stakeholders of city administration authorities and SMEs involved in the delivery of smart city services we analysed, categorized and prioritised the requirements to fulfil all project objectives. Two development, integration and testing iterations followed which run in parallel with the operational and business processes for the definition of the roadmap, and which facilitated our vision for a smart city environment. Furthermore our approach introduces the development of a new proof of concept application which will be composed by other pilot application services that are instantiated and deployed on the platform. This proof of concept application was created exploiting the EPIC solution (platform and roadmap) for a city with limited background or experience with smart environments.

When developing new ICT products it is essential to investigate the user needs and requirements for new services and solutions and to elaborate appropriate concepts that relate to these specified needs and requirements. Living Labs build specifically on the belief that gaining insight into the user and the usage context is one of the main critical determinants for successful product development processes [10]. Living Labs can be defined as a form of open innovation [11], but its activities distinguish themselves from other approaches by confronting the user with technology (e.g., prototype) early on in the innovation process, within their natural environment, and by approaching the user as the co-producer of technology [12, 13]. Therefore, Living Labs create an innovation environment that consists of all relevant stakeholders underpinning a research methodology that allows to grasp and understand user reactions towards the new technology and to let the test results flow back to the development. The Living Lab approach is nowadays getting momentum in Europe, as shown by the creation and successive expansion of the European Network of Living Labs (ENOLL). In its creation of smart city services and a pan European platform, the purpose of the EPIC project was to use the potential of the Living Lab innovation, highlighted in 2009 by ALTEC [14] in its review of Living Lab practices.

Practically, this meant that for each pilot application a three stage development process was executed. Each stage had its own goal, addressed a specific type of user and was iterative. The closed group stage, consisting of two iterations, aimed at testing with a small group of technically skilled end-users whether the prototype was technically working well. The open

group stage, having three iterations, launched the prototype into the broader community. For each iteration, new testers were recruited with the exception of a small group of end-users that participated in multiple iterations in order to verify the validity of the results. The final evaluation stage consisted of two dimensions. On the one hand, stakeholders, i.e. companies and public institutions were asked to evaluate the pilots. On the other hand, the three services were migrated as proof of concept to the Romanian city of Tirgu Mures and tested by end-users there in order to validate the cross-border usefulness of the EPIC approach.

The following quantitative and qualitative methods were used to grasp user responses towards the prototype, surveys, focus groups, interviews and event logs. The measures to understand user experience and acceptance were (a) perceived ease of use, (b) perceived usefulness, (c) content quality, (d) attitude and (e) intention to use. Moreover, in surveys as during interviews and focus groups, users could give us their suggestions how to further improve the services and about which functionalities are helpful or not. Finally, in the stakeholder evaluation phase, we also asked companies and public institutions whether the pilots had the potential to contribute to making cities smarter.

3 EPIC Core Components

Following this innovative approach EPIC delivered a holistic solution for smart cities which includes a) a cloud-based platform for smart city services, b) a set of pilot applications and services that cover a wide range of features and requirements of modern cities, and c) a roadmap guide for the effective transition of cities, citizens and SMEs to the new paradigm.

3.1 EPIC Platform and Core Services

The *EPIC Platform* provides the technical underpinnings for delivery of data and services through a cloud-based environment. The EPIC platform is based on the Java EE (Enterprise Edition). The Java EE enables developers to create reusable, platform-independent modules like, e.g., Enterprise Java Beans (EJBs) and Web Services (WS). In EPIC, we strictly adopted the Service Oriented Architecture (SOA) paradigm while web services are widely used [3]. In this paradigm, (large) software applications are composed out of a number of services. Services are distinct, self-contained and loosely coupled software pieces providing a single functionality like querying a database or submitting an order. This implies that each smart city service is remotely accessible over standard Internet protocols independent of platforms and programming languages allowing for more extensive and effective (re)use of services and data. Vice versa, by adopting SOA design principles, we are able to invoke third-party web services as well, which is fundamental for service integration. In particular, it is necessary if an application expected to run on the EPIC platform depends on data or functionality which can only be provided by a third party. Such an integration of a service over the Internet enables, e.g., embedding Open Data in own applications and different kind of collaborations like Private-Public-Partnership. The Relocation Service Application (cf. section 4) is an example of an application that realizes a Private-Public-Partnership by the integration of an Open Data Web Service.

Figure 1: EPIC Platform Features

The *interoperability* feature of the EPIC platform is driven mainly by the need that the hosted applications should be able to consume data feeds from different of sources and to exchange and correlate these data among them. A variety of industrial equipment producing monitoring data to be published within the platform must be supported, as well as the ability to interconnect SMEs wanting to use solutions that include subcomponents, implemented in different programming languages, being deployed on different servers, hosted in different operation systems, and consuming data feeds from a variety of sources. EPIC's *security* is driven mainly by the necessity for the platform to be able to allow stakeholders to provide specific credential and trust evidences in order to register and consume the desired services. Different types of end-users are allowed to access different services depending on their roles. For this reason, secure based authentication and authorization is provided. EPIC *City Portal* aims to organize and display a comprehensive layer of existing city information, alongside access to chosen web service applications residing in the EPIC cloud. More specifically, the EPIC cloud platform provides a portal server managing the role-based look and feel of the EPIC portal for different stakeholders, e.g., city civil servants, application providers, citizens. Based on different authentication means, these personalized portals provide either immediate access to services (single sign on) or allow the user to search for currently available services. Additionally, the EPIC City Portal will enable the exposure of some of the available services as separate "widget-like" Portlet [4] applications to be used anywhere on the Web.

Moreover, EPIC takes a two-fold approach to supporting *mobile devices*: devices with a standard browser can access the normal EPIC pilot services via the portlets delivered by the EPIC portal server, and device-specific app which are executed on the mobile device and through which it will consume the web-services provided by the EPIC platform, allowing access to device-specific hardware such as GPS and camera from the app. The current fragmentation and multi-culture and multi-language nature of the European environment makes difficult to promote and share, innovation across the European public sector. To address this challenge, EPIC includes translations and *semantics* to facilitate multilingual access laying the foundations for easy cross-language adaptation and communication within the Cloud. One of the most innovative aspects of the EPIC Platform is the use of the *"Internet of Things"* to provide common middleware for advance, future-oriented smart city services. Under the EPIC Smart City vision, objects will be able to "think", "feel" and "talk" with each other, making it possible for city administrators to monitor and control these objects everywhere and anytime and ultimately create an intelligent or smart service.

Service Orientation is enabled by an important Element of the EPIC platform, namely the *Enterprise Service Bus (ESB)* [16]. The ESB transparently translates between communication protocols and transforms data among different formats. An application usually consists of a variety of different web services. An application provider can offer its solution as a whole, and

additionally, can offer some of the implemented services to be used (and paid) by other providers, as the SOA model suggests. A web interface provides access and search tools in order to investigate if there already exist services that could provide the core system of a brand new application, or enhance an already existed one. Every new web service that will be accommodated by the EPIC platform must be registered to the EPIC Service Catalogue. The latter simplifies and enriches the discovery of the registered web services, as the user can use multiple criteria to find the one that fit best their needs. Moreover, the platform can provide content-based search mechanisms that rely on the semantic annotation of the web services, as described above. Service Catalogue provides the tools for an easily integration of the new web services, translate the different formats transparently, while giving the opportunity to define policy models for proper authorization and price models for the proper allocation of the common revenue. This core component of EPIC has been widely exploited by the EPIC Roadmap.

3.2 EPIC Pilot Applications

For the effective design, implementation and validation of the EPIC Platform three *pilot applications* were used that pose supplementary requirements and exploit different EPIC elements. These pilots offer innovative services for *Relocation*, *Urban Planning* and *Smart Environment* making use of the platform features for Semantics, Portlets and IoT advancing the "intelligence" of all involved stakeholders: City Administrators, Citizens and SMEs. The *EPIC Pilots* demonstrate the use of the EPIC platform and the EPIC concept in a wide range of scenarios that encapsulate many of the city, citizen and business needs of a smart city platform. Although, the three pilots were initially developed for specific cities, Brussels, Manchester, and Issy-les-Moulineaux, in order to evaluate and validate them against real data, they can be readily re-purposed for other cities as demonstrated through the proof of concept in Tirgu Mures.

3.3 EPIC Roadmap

In establishing a holistic approach for smart city services and smart cities in general, a high-level guidance would be expected to help cities and city administrations in understanding their vision and developing the plans for implementing smart city services. As such, the Roadmap presents a concrete and useful business tool for cities and city administrations in their journey towards a smart city and the implementation of smart city solutions. The high-level phases that are included in the EPIC roadmap are depicted in the following figure and start from the *Vision* and the *Plan* phase towards the *Design*, *Build* and *Deliver* phase. Finally, the *Operate* phase defines the continuous activities for running and maintaining the smart city solution.

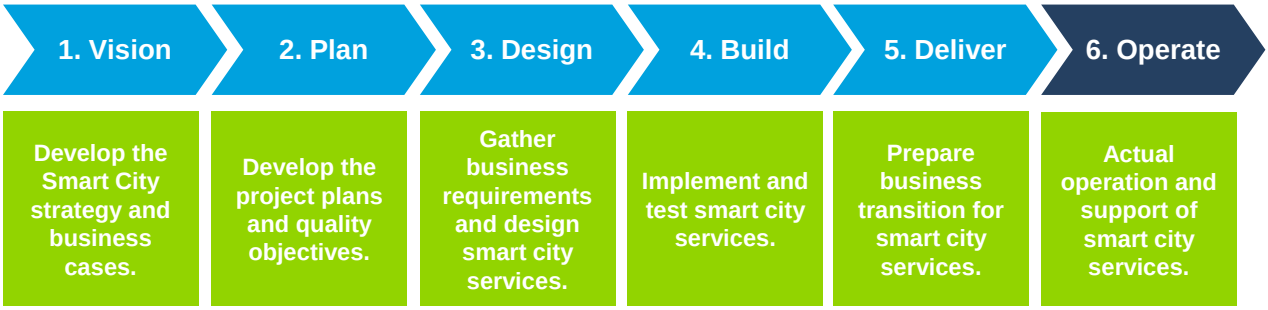

Figure 2: EPIC Roadmap Processes

The initial vision phase of the EPIC Roadmap uses a strategic smart city framework to help cities elaborate and defining their smart city vision and strategy. This framework assesses a city's current smart maturity according to pre-determined strategic values including Legal, Financial, Operational and Technical, which will help identify and define potential strategic smart city initiatives. In establishing the business cases and concrete project plans for realising the smart city vision and strategy, the EPIC Service Catalogue provides an opportunity to discover potential relevant and innovative smart city services. As they already exist in this Service Catalogue, it will be easy and efficient to transform the smart city service to the new specific context using the cloud-based capabilities of the EPIC platform.

The EPIC Service Catalogue provides the cornerstone for delivering and managing smart city services. It will provide the starting point for any city administration or SME to investigate the service possibilities offered by platform: (1) to leverage and use existing smart city services, or, (2) help service providers develop and migrate new smart city services. As such, the EPIC Service Catalogue allows the service provider or external integrators to carefully define and select the most appropriate services for their specific purposes.

The following figure depicts the overall structure and relationships between the stakeholders and the high-level components of the EPIC platform. This platform provides the innovative cloud-based environment for running the different types of smart city services, as was also described in more details in the previous sections. Based on the service orientation, the use of open standards and the integration of security measures as part of the EPIC platform, this environment ensures trustworthy relationships between users, external suppliers, the city ecosystem and EPIC itself. This will then facilitate the establishment of clear financial flows and structures, as part of the business case and operational agreements.

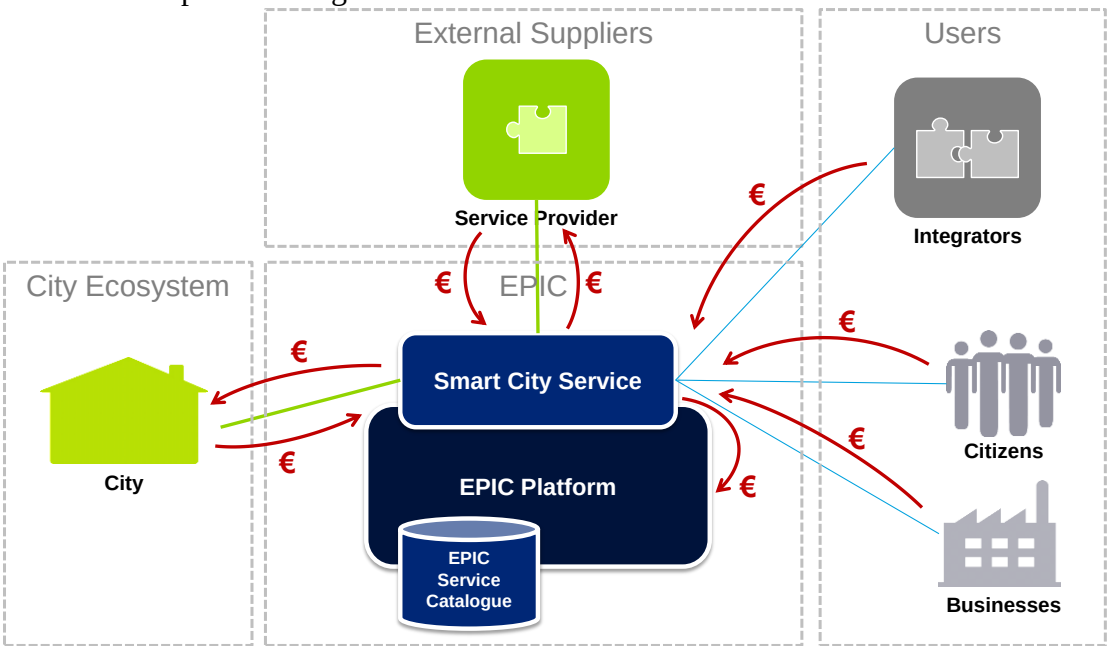

Figure 3: EPIC Business Ecosystem

The living lab approach to build the pilot services and the final proof of concept ensure that also the integration and the evaluation of additional services to the EPIC platform is an efficient and productive way to develop a smart city.

4 Experimentation and Results

4.1 Relocation Pilot Application Experimentation

The relocation application for Brussels follows SOA design principles and it can strictly be divided into web services and portlets (cf. figure 1). The essential idea in the relocation application is to establish a private-public partnership by aggregating:

- **public data**, e.g., Points Of Interests (POIs) provided by the City Administration including transport facilities like a metro network, security and healthcare institutions, educational facilities, etc. and
- **private data** in form of offerings of real estate agencies. These offerings include apartments and houses for rent and for sale.

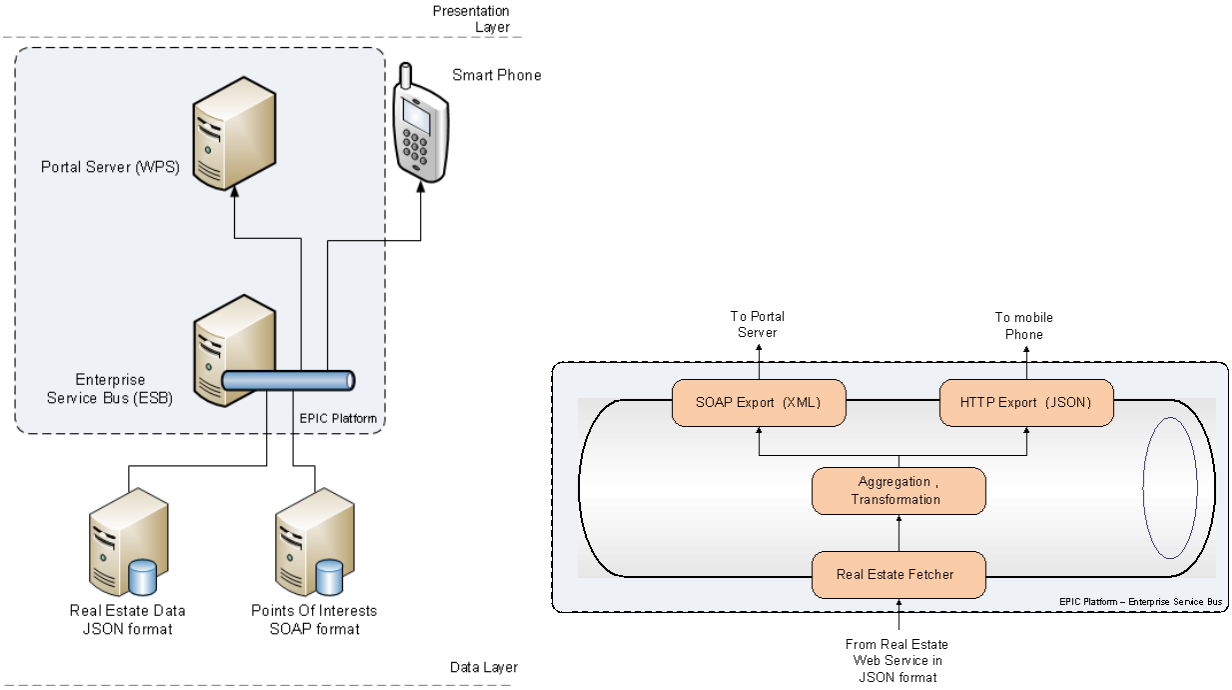

Figure 4: Architecture and Information Flow of the Relocation Application

The two data sources have been provided by third party data suppliers as Web Services, but depending on the city for which the relocation application is deployed, the format of the data sources varies. For instance, in the case of Real Estates of Brussels, we use a Web Service of a Real Estate Agency in JSON format (see Figure 4). On the Enterprise Service Bus of the EPIC platform the Real Estate data is fetched and transformed. In addition to some cleaning of the data and making it suitable for our usage, transformation means to transform the data into the appropriate format. In the context of this application this is necessary, because Portlets consume Web Services most conveniently in SOAP/XML format while Smartphone Applications conventionally consume data JSON format (Figure 4).

Working within the general Living Lab approach and methodology explained in section 2, the implementation of the user tests was executed as summarised in the table below. From a smart city perspective, the relocation pilot had the aim of contributing from a citizen side to smart living and mobility (facilitating and smoothening the exploration of interesting places to live when moving to a unknown city), from a public authority side foster smart governance (helping citizens by providing open data, get more info about expats movements in the city, and finding ways to smoothen interaction with local authorities) and from a company side smart economy (helping to detect needs and demands of relocating expats to streamline their offers better to expats).

Table 1: Relocation Pilot Experimentation Process

Stage	iterations	testers	methods
closed group	2 for web 1 for mobile app	technically skilled users	survey/logs
open group	3 for web 1 for mobile app	* one time experience users * advisory group	survey/logs + participant observation for mobile application
evaluation stakeholders	N/A	companies, public institutions and organisations	interview, survey

The iterative approach allowed us to constantly improve the design in line with end-users' expectations and wishes. This ranged from rather small improvements (e.g. choosing different icons for houses or flats, for rent or for sale) to important design options regarding property search criteria that relate directly to the aim of our pilot, enabling a smooth and efficient property search. As such, we were able to separate points of interest categories (such as Public Transport means, Education facilities, emergency services) that are crucial when users set the broad parameters of their living preferences from points of interest categories that are more relevant when exploring properties in detail (such as cultural infrastructures, parks and sport areas). Secondly, the Living Lab approach helped us to develop a clear differentiation of icons for the different types of points of interests that is critical, not only for navigating purposes, but also for understanding the meaning of a large amount of them on a map. Finally, our approach also helped us to identify price-settings and distance settings (choose your distance from a point of interest) when defining the criteria for property search.

Table 2: Relocation Pilot Experimentation Results

Measure	**Feedback (end-users and stakeholders)**
Ease of use	Simple design, intuitive, easy to learn
Usefulness	Combination of property data and point of interest and web and mobile very useful

Look and feel	Out dated for web; very good for mobile
Content quality	Rich information, covering various aspects of the relocation process
Acceptance	Satisfied with amount of time to find property on pilot, essential application a city should offer
Intention to use	End-users: definitely, although improvements needed (like look and feel and new design features) to increase use value Stakeholders: improvements on level of design and look and feel needed before advising to use to their customers/clients

Regarding the measures used to grasp user experience and acceptance, the user tests throughout the closed and open group development track and the evaluation by stakeholders taught us that our pilot is considered as an easy to use, intuitive useful tool with a simple design underpinning relocation purposes. Attitudes towards the proposed solution were generally positive, although the intention to concretely use the web or mobile component or the integration of both in an actual relocation situation seems to depend on further development of the pilot, especially in terms of the look and feel of the web component and the incorporation of extra functionalities in both web and mobile components. The look and feel of the web application was considered to be 'old fashioned' yet should aim to be 'upgraded' to a mere Web 2.0 interface. The major additional functionalities that were suggested/requested by end-users and stakeholders included, better 'orientation' functionalities (e.g., search on address, highlighting known landmarks, profiling neighbourhoods and municipalities), enriching point of interests with useful information (e.g., providing opening hours of supermarkets or number of metro lines for metro stops) and implementing recommendations and rating systems for individual use or for sharing purposes towards other expats using the service.

What concerns the smart city objectives specific to the relocation pilot, stakeholders saw our prototype indeed as model that could contribute to organize mobility and living in a new unknown city for expats in a more efficient way. Especially (1) combining point of interests with property criteria in the search functions as well as selecting the distance from a point of interest; (2) displaying points of interest on a map in the detailed discovery of property; and (3) being able to generate a list of favourites and adapt this list based on new discoveries or executed visits, were identified as promoting smart living and smart mobility when moving to a new city.

In the case of stakeholders that represented city administrations, the smart governance potential was acknowledged in that the application would already reach out to expats when they were still abroad and would provide a reliable solution. In this sense, it can be a useful tool for expats abroad to get a bit acquainted with the Brussels' city administration. The potential of the city view feature as a means to provide anonymously aggregated data about expat preferences and needs when moving to Brussels was evaluated as a possible interesting tool to better streamline policy that targets expats. Stakeholders that represented private businesses made similar evaluations about smart economy. The solutions tested could enable businesses to already reach out to potential expats prior to their arrival in Brussels, while the city view has the potential to gather useful information to streamlining private services in a more efficient way towards expats.

In addition to yielding insights into design changes and assessing the smart city value of the pilot, the third benefit for EPIC in adopting a Living Lab approach lies in the fact that crucial issues for keeping the use value sustainable beyond EPIC were rapidly identified.

In the case of relocation, the main concern was the reliability, actuality, sensitivity and maintenance of the data provided. In relocation for example, testers of the mobile application indicated some Point of interest like sport clubs that did no longer exist. On the other hand, community information needs to be handled with care. In our case, we decided not to include some of this information like air and noise pollution since they were measured some years ago. Secondly, there is also the sensitivity issue of some data: while some testers asked to incorporate crime statistics and statistics about demographic composition of neighbourhoods, we deliberately chose not to do so in order to avoid stigmatisation of certain areas. Thirdly, the Living Lab approach made it clear that open data often needs remodelling: they are collected and organised within the logic of the institutions that gathered them and often need adaptation to the specific end-user. Working out such strategies about maintenance and sensitivity are thus crucial for the sustainability of the service.

4.2 Proof of Concept Application Experimentation

For this experiment a proof of concept application has been developed applying the roadmap in the city of Tirgu Mures, which served as test city. This "find a house" application exploited the relocation pilot application services that were deployed and instantiated on EPIC Platform in order to demonstrate its unique features for advanced customization and reusability. In the following, we discuss the steps of adaptation and implementation that had been done for the proof of concept using the example of Brussels' relocation service.

The adaptation and implementation steps had been:

- Data on properties in Tirgu Mures was exposed through a web service created by the city, to replace the initial web services used in Brussels.
- An EPIC platform web service was created to wrap the Tirgu Mures property web service and present data to EPIC users in the same way as the Brussels property wrapper web service.
- A point of interest (PoI) web service was created by the city of Tirgu Mures to replace the original Brussels PoI service.
- An EPIC platform web service was created to wrap the Tirgu Mures PoI web service and present data to EPIC users in the same way as the Brussels PoI wrapper web service
- A Google map of Tirgu Mures city was used as the baseline map over which Tirgu Mures specific data from the Tirgu Mures property and PoIs web services were overlaid in the Tirgu Mures relocation portlets.

The adaptation of the relocation service of Brussels to Tirgu Mures was a straightforward process. In order to adapt the relocation application to another city only minimal changes are needed for the portlets. More important, Tirgu Mures was requested to provide equivalences for the two web services used by the relocation application, namely a Real Estate web service and a PoI web service, as shown in the lower portion of Figure 5.

Because the data services for PoIs and Real Estates of Tirgu Mures were not entirely equivalent to those used in Brussels, mediating web services were created that performed the necessary conversions. This again demonstrated how the EPIC web services, acting as mediators, present a standardised interface to "insulate" developers from differences in the third-party web services exposed by the data owners. Figure 5 presents the adaptation process as it had been executed.

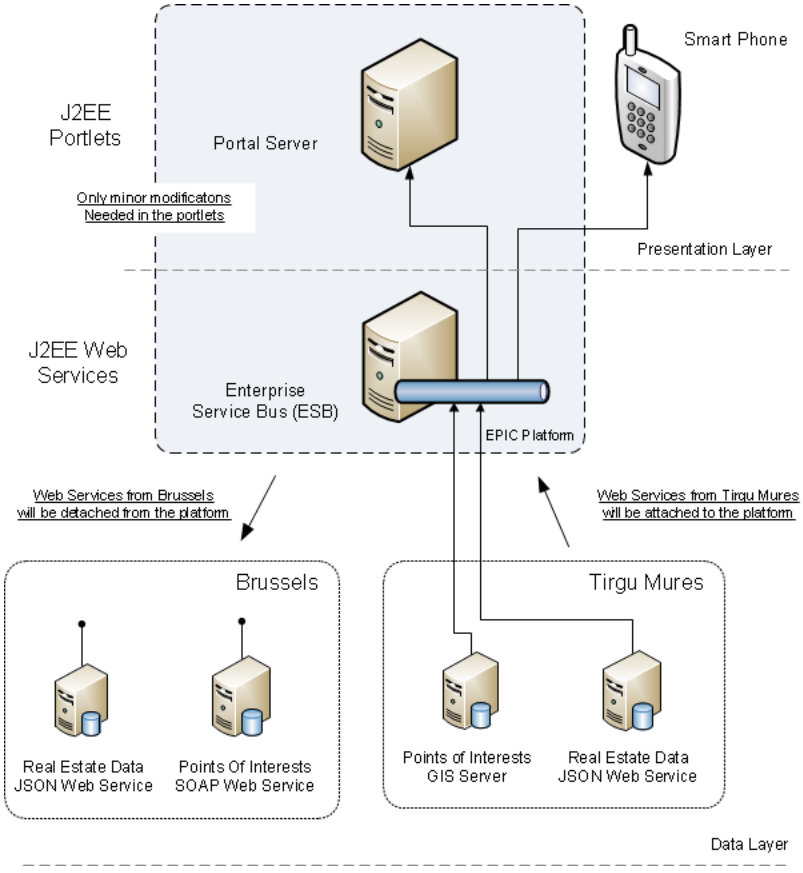

Figure 5: Data web-services in the proof of concept

"Find a House", the adaptation of the relocation pilot, was also validated by a Living Lab approach following the same strategy in phases and same methodology and evaluation measures as the smart city services in the three pilot cities. After a closed group testing to make sure the service was technically working from an end-user perspective, the pilot was launched in the wider community in the open group and evaluated by companies and public institutions in the city in the evaluation phase.

The test results were in line with the insights gained in Brussels, thus validating from an end-user perspective the pan-European usefulness of our pilot. The application was considered to be useful and easy to use and as a tool that would be very helpful in better finding potential interesting property in Tirgu Mures and organise their exploration in the city. As such they expressed a positive attitude towards the application, testified to have an intention to use or recommend it to people who have to move to the city and validated as an essential service for their city. Stakeholders expressed the potential for smart living and mobility as well the benefits the pilot could gather for smart governance and smart economy.

5 EPIC Added Value

EPIC consists of services, tools and policies, which support cities to become "smart(er)" and to implement their digital agenda. By exploiting the EPIC platform capabilities and the roadmap, cities can provide "intelligent" applications with an advanced set of technical, functional and business capabilities, based on the particular requirements of the city council, citizens and participating SMEs. Following the validation of the outcomes in the proof of concept it is important to look at how EPIC will help cities, citizens and SMEs across the public service delivery chain.

5.1 Cities

Enhance ability to provide more innovative, efficient and effective services at reduced cost: EPIC is a validated concept that has delivered a practical and flexible solution for Cities wishing to begin their Smart City journey. Cities can use the EPIC Roadmap to better understand what "smarter" working could mean for them and help them plan a personalised strategic approach to becoming smarter. In addition to the consultancy help, the EPIC Platform enables new smart services to be adopted between cities and be rapidly deployed in a cost-effective manner.

New business models and working relationships with other cities and improved relationships with citizens and businesses: A Public-Private business model was adopted for the development of EPIC and this model of working is to be continued for the subsequent sustainability of the solution, unlike the solely Private approach of our competitors. Through the Public-Private model, the EPIC Service Catalogue effectively becomes a service marketplace between cities and SMEs with EPIC acting as a 'broker' of smart services and smart data. This feature, to-date, gives EPIC a key differentiator in the Smart City marketplace where the majority of solutions are proprietary to the platforms that are providing them.

City Digital Strategy enhancement: EPIC has created an opportunity for the city to experience first-hand the deployment of software as a service (SaaS) and to look at a cloud computing platform that not only contributes to the delivery of services to its citizens but also provides a new way to develop online services for citizens and realizes the city's Digital, Corporate ICT and Environmental Strategies.

5.2 Citizens

Access to more innovative, efficient and effective services: During the project citizens in the pilot sites had access to new smarter services through the Cloud. These services are available through EPIC Platform for use by cities across Europe to offer to their citizens.

Enhanced ability to help improve public services: For the pilots the EPIC Services contained a feedback loop for citizens to easily share their user experiences and help them be improved through an iterative testing process.

5.3 SMEs

Greater access to local and international markets: Through the platform and the supporting services EPIC provides the ability for SMEs to access markets outside their own network.

Ability to work more cost-effectively via the EPIC Cloud platform: The service components available on the EPIC Cloud environment provide innovation elements available for SMEs to utilise to enhance existing services and/or create new ones that can be migrated to the Cloud. For example the Clouds privacy and security layer provides a cost-effective resource for SMEs providing their service through the cloud.

6 Conclusions

In this paper we presented an innovative approach, which offers ample opportunities for sustainable "intelligent services" that will enable smart cities to realize their digital agendas. The proposed platform combined open innovation processes, advanced e-Government service applications and computing technologies to create a truly scalable and flexible pan-European ecosystem for effective, user-driven public service delivery. Our work offers public administrations an opportunity to reduce costs and to drive innovation by providing them with access to a market-leading shared infrastructure that facilitates rapid prototyping and testing as well as wide accessibility and availability.

Information and communication sources which are currently available to the city councils and consumed by specific applications, can be adapted to the platform and offered as services in order to be exploited by any application across the cities borders improving the business models and enhancing relationships with other cities. EPIC enhanced the offered platform by also developing a roadmap tool, which serves as a guide and best practices handbook to become a truly smart city. This significantly accelerates the business plans of cities and SMEs and overcomes the fact that the public sector is always seemingly slower to adopt these new technologies. EPIC is expected to provide more efficient, effective and lower-cost services and which will be brought to the market faster, enhancing the collaboration between citizens and businesses through a pan-European open innovation ecosystem.

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