DELIVERABLE

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Adaptation Rules & Criteria for EPIC Scenario

Version 1.0

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1 Introduction

1.1 Objectives

The purpose of this document is to describe the changes and the technical adjustments that were necessary to apply at the various stages to the EPIC pilots: "Urban Plan", "Relocation" and "Energy". There were several iterations of this project done with the living lab approach and the technical improvements of this process are the subject of this deliverable. From these experiences a set the rules were defined which are required for any city asking to be integrated as client of the EPIC platform. The exercise of the "proof of concept" done with the city of “Tirgu Mures” enable to clarify what was necessary to adapt and how to do it with the City. The final result of this exercise is to validate rules and necessary adaptations to the needs expressed by any city as a client.

For each pilot we had much feedback of the use and users all along the project. The experience was rich with the exchanges with the cities involved in the project and with technical teams of EPIC. Lots of important information was gathered during the testing phases due to the different profiles of users and with many meetings, surveys, and with the presentations at events and conferences. From these experiences and our different development activities, we were able to enrich and improve our response to the expectation of the EPIC project. We were also able to adapt our products beyond the needs identified by the pilots. Based on the analysis of feedback from users, cities and enterprises and our expectation to make available our concept, solutions and services beyond the end of the EPIC project, we have defined rules (or processes) and criteria for any new applications for all cities aspiring to become an intelligent city: a Smart City.

These rules and technical adaptations will conclude the chapter of each pilot and can be used as guidelines of the functional and technical specifications, providing a view of the organization, effort, workload and planning required to adapt the application or any new features within EPIC, for any city client that would like it for themselves as a solution or service, and to make it available and working.

1.1 Methodology

Here is the framework that was used for this delivery and how, step by step, what we have used what we have learned per phase for each pilot, in order to put in place the “proof of concept” with Tirgu Mures. Finally having rules and criteria built, including some additional input for the business process and a road map well for a well-known deployment phase, what this means for the post EPIC period with commercialization.

What we need to start:

- Description of EPIC and available services (the context)
- Initial functional specifications (the promise of Pilots)
- Specifications of the needs expressed by the PoC Client and the future requirements, including Descriptions and Processes for each of these points:
    - What is "required" -> what we should implement (must have)

  - What is "flexible" -> what we can implement but is not mandatory (nice to have)
  - What is "modular" -> the client can ask, but not yet covered by the service (dream to have)
- The technical specifications of each element of EPIC / Company
- The process of validation and implementation by phase
- The testing process (living lab)
- SWOT and Analysis
- Decision process by state and PoC Deployment
- The deployment process

PROTOTYPES PHASE

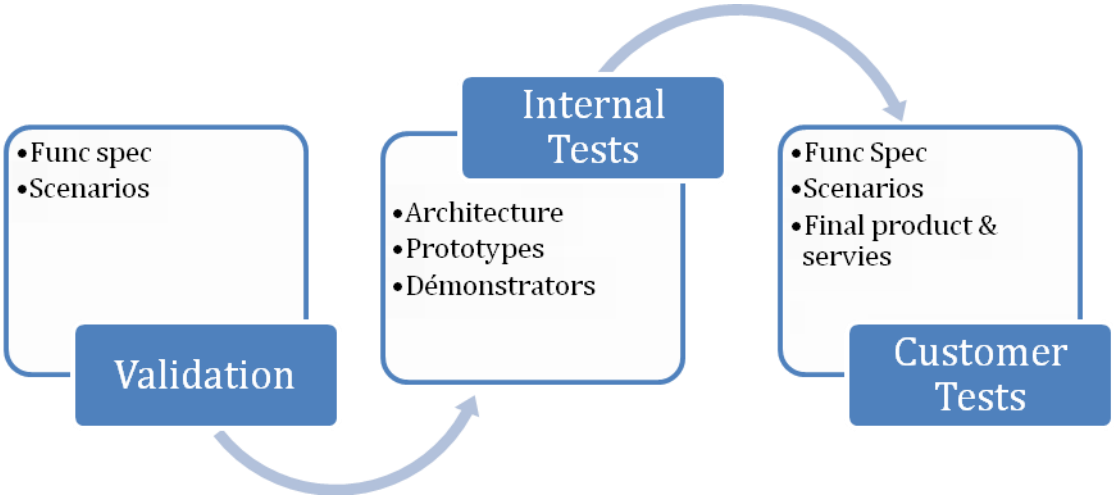


Figure 1: Process for the prototype phase

Tests process: with difficulties encountered and impact during tests

- Internal tests analysis
- Strengths, Weaknesses, special requests: analysis of results
- Conclusions and actions taken by each pilot/EPIC: document functional coverage and technical aspects

User tests analysis (citizens and business)

- Strengths, Weaknesses, special requests: analysis of result
- Conclusions and actions taken by each pilot/EPIC: document functional coverage and technical aspects

SWOT and analysis: Make a SWOT for each pilot (companies) and the platform

PROOF OF CONCEPT PHASE

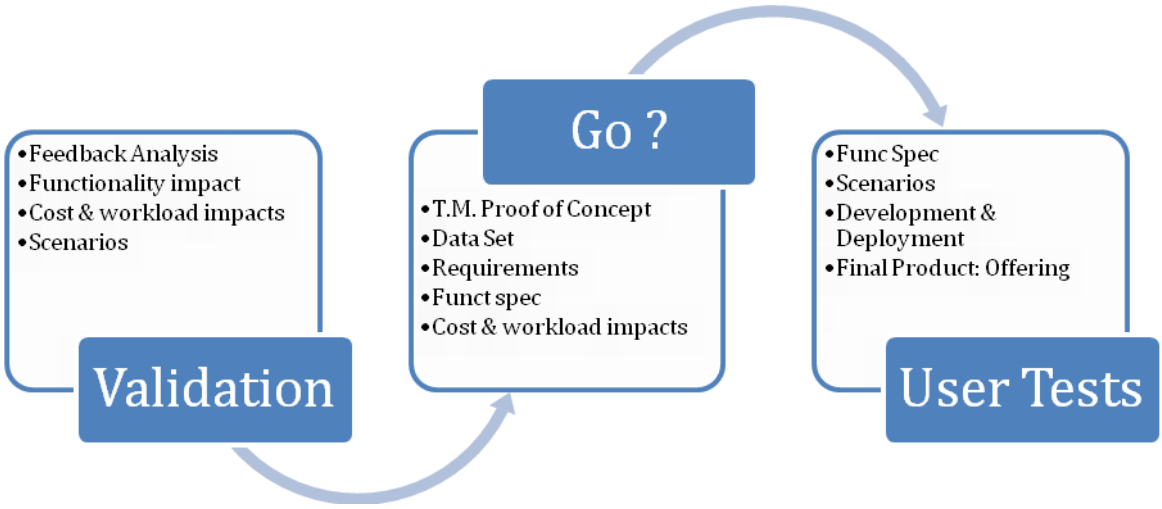


Figure 2: Process for the proof of concept phase

Experience acquired on initial prototypes:

- Analysis of needs of the new pilots (TM)
- Pilots Demonstrations, identified needs, special requests
- Conclusions and actions taken:
    - Governance & Identification of actors
    - Available and missing data
    - Functional specifications

Implementation of pilot

- Technical specifications, testing scenarios
- Strengths and Weaknesses of the governance in place

SWOT and analysis: how to prepare a deployment phase based on TM & previous experience

DEPLOYMENT PHASE

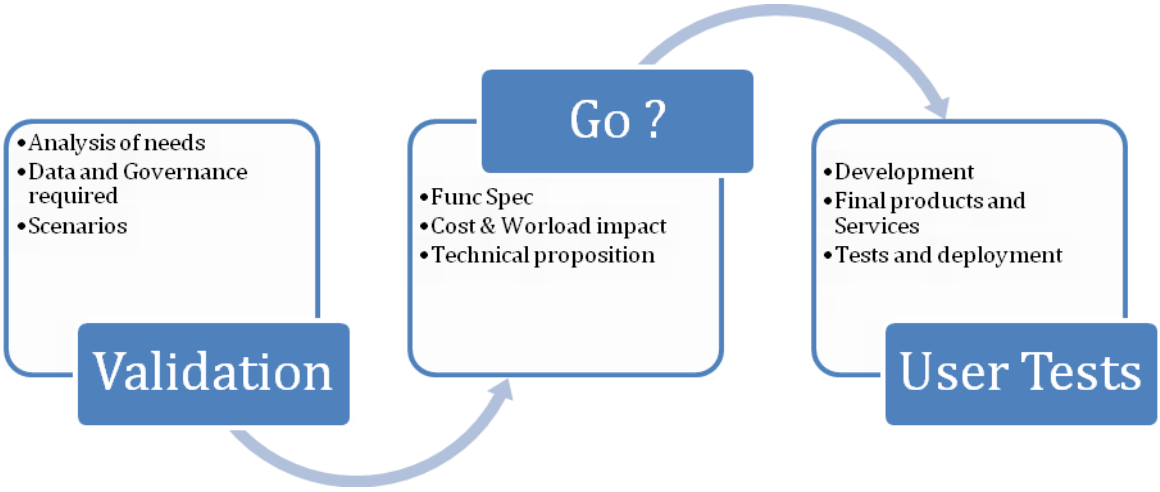


Figure 3: Process for the deployment phase

Experience based on initial prototypes and "Proof of Concept"

- Description of materials for products and services (marketing documentation)
- Promotional materials (videos & testimonials)

Proposition: Commercial products and services

- Compliance with requirements and available information
- Specifications, figures and numbers (costs, workload, resources, …)
- Business Model and a sample of Customer Propositions

Deployment:

- Planning including adaptation and development for facing the customer
- Tests, Reviews and Tips & Tricks

SWOT and analysis: will be mandatory to do with each client to enrich the experience and improve "EPIC" with all applications and services delivered

2 Overview of the three pilots

This chapter provides an overview over the three pilots “Urban Planning”, “Relocation Service”, and “Smart Environment”.

2.1 Urban Planning

This section provides an overview over the Urban Planning pilot. First, the scenario description for the pilot is presented. Then, a more technical description is provided.

2.1.1 Scenario Description for the Urban Planning Pilot

This subsection describes the scenario for “Urban Planning” from different views. These views result from the kinds of people who will access the EPIC platform and use the Urban Planning application. In particular, there is a paragraph about the citizen view, a paragraph about the city view, and a paragraph about the enterprise view.

2.1.1.1 The citizen view

A typical end-user connects to the EPIC platform and accesses the Urban Planning service in order to get information about the city’s layout and its major sites as well as planned changes. The service enables the user to virtually fly over and to move around the digital 3D model of the city, and to enter major sites. Registration is not required at this stage, but if the user wishes to interact with the service, the content administration tool has to be accessed and the registration procedure will then be launched.

The user can opt for a general discovery of the city, or he/she can choose a specific topic of interest (Leisure and Culture, Sustainable Development, Urban Planning projects, Public Services, Enterprises).

After selecting the main topic, the points of interest in the city associated with it are highlighted on the 3D map. The user then can simply fly over the city and choose the POI he/she would like to have information about. By clicking on the desired item, the user has access to a media centre providing general information, pictures and videos. He/she can also take a virtual tour of the place or access its web site, for more detailed information.

By selecting the topic “Enterprises”, the user can view all the companies registered in the city (in a 3D aerial view). Again, additional information is available, in this case provided by the respective company itself. This information might contain photos, presentation videos, latest job offers or (again) a website for further information.

If the user has an idea about the point of interest he/she is searching for, but is not sure where to find it (i.e. in which topic), he/she can use the search query for a fast finding and locating of the point of interest in question.

In sum, the Urban Planning service will allow the citizen to discover the economical fabric of his/her city in a 3D view, to obtain information about a specific enterprise and to get in contact with that enterprise if he/she wishes.

2.1.1.2 The city view

The Urban Planning service is also very useful for the city administration, allowing it to maintain up-to-date information on the platform (content and media) via a novel administration tool.

At the same time, the service offers the city administration a detailed view of the local economical fabric, in order to follow its activity and stay up-to-date with the latest news and events in the sector. It will also allow the city administration to measure more easily the evolution of the occupancy rate of buildings by business district.

2.1.1.3 The enterprise view

The section "Enterprises" of the Urban Planning application offers an overview over existing innovative businesses within the city. An SME wishing to make itself known and to share information about its activity may register to the platform. Specific registration procedures then will allow the SME to be geo-located on the 3D city map. In addition, an editing tool will allow the SME to publish (and afterwards update) all data related to its activity, including information about products and services offered, pictures and presentation videos as well as job opportunities.

A regular SME accesses the section "Enterprises", wanting to inquire about similar products and services in the city or simply just to get an idea about other companies located in the city. After selecting the topic, all the city's SMEs are highlighted on the 3D city map. By clicking on one particular SME, information such as photos, presentation video, or the official website for further contact appears. The authentication procedure is launched if the user wishes to get in direct contact with a particular enterprise.

A private communication system (possibly in the form of a forum and accessible via the user's personal account credentials) will be put in place in order to allow fast exchange of information and to enhance the communication flow among the SMEs.

In sum, the application has a double-oriented approach: on the one hand, a B2C approach allows enterprises to inform the citizens about the services offered and about job opportunities and on the other hand, a B2B approach provides enterprises with a better knowledge of the economical fabric and identifies potential competitors and partners.

2.1.2 Description of the Urban Planning Pilot

The Urban Planning application allows cities to have a tool of communication that can be used by the public, to organize consultations around an urban project with architects and civic associations and a tool for taking decision used by elected officials and technical services of the city.

Depending on available sources of data, Navidis is able to offer within EPIC on a 3D mapping, an interactive and multimedia-modelling city:

- Display geo information enriched with media in space and time

- Display dated urban projects (time line)

- Propose different levels of representation, from symbolic to realistic.

- Thematic display through layers or categories or by the introduction of a consultation filter

- Design urban elements (lighting, trees, structures...) or places from LOD1 to LOD 4 anywhere in the 3D model.

- Interpret data and transform it into information to give them meaning and be understood by different public without technical, specialist or expert support

- To manage dynamic data in real-time such as mobile phone, energy, transportation flows...

- Propose templates, forms and models for dashboard or any kind of representation



Figure 4: Screen shot of the 3D model of Issy-les-Moulineaux

With this application, the city can a) communicate with its internal team to develop a strategy, b) evaluate urban projects with its partners and service providers, and c) inform citizens on issues, projects and local initiatives. This application can also be used to monitor projects, to initiate consultations, and to train administrative and technical teams to the vision and the development strategy owned by the official elected.

In order to realize the application, we have advanced by step:

1. develop within EPIC an Urban Plan for the city of Issy-les-Moulineaux,
2. include an economic layer and take into account user feedbacks,
3. develop within an EPIC a "Smart city" model for the city of Tirgu Mures which includes
   - 3D modelling
   - modelling in LOD2 some places
   - integrate the POIs of the city
   - integrate "energy" data from energy monitoring pilot (cf. section 3.3)
   - integrate the "Real Estate" data from the relocation pilot (cf. section 3.2)

For this we have developed a framework consisting of an "Editor" and a "Player" based on the game engine Unity 3D which "*is a game development ecosystem: a powerful rendering engine fully integrated with a complete set of intuitive tools and rapid workflows to create interactive 3D content; easy multiplatform publishing*".

This Navidis 3D Framework

- is scalable

- can act as a middleware within EPIC or not, remaining adaptable to any type of infrastructure

- has its own set of program interface to implement

- designed customer interfaces
- model and representations of static or dynamic data
- set of interactions on dot, line or volume
- for adding enriched features
- for aggregations of services developed elsewhere

- supports various devices like PC, MAC, Touchscreen, Tablet, Smartphone

In sum, the Urban Plan application offers cities a communication tool to enhance the territory in 3D. In addition, it provides the ability to connect the city with its enterprise eco system and its citizens, helping to launch consultations and to examine issues of the territory. Using 3D technology like video games makes this application easy to use, immersible, fun and flexible to provide any type of interactive and multimedia information.

2.2 Relocation Service Application

This section provides an overview about the Relocation Service pilot. Again, the respective scenario description is presented first. Then, a more technical description is provided.

2.2.1 Scenario

The scenario for the Relocation Service Application is described from the perspective of two major use cases: a web and a mobile application that work in tandem to create an application that assists people moving to a city and find the right place to live (see also D5.1, D7.1 and D8.1).

The web application can be used before moving virtually through the city from any location in the world, while the mobile application aims at supporting a user in their first real explorations of the city, while visiting a shortlist of candidate properties found via the web application.

2.2.1.1 The future citizen looking for a house via the web interface

2.2.1.1.1 Where to live

Prior to moving to the city, the application wants to assist a future citizen in getting to know the different areas of the city. A common need of future citizens, as confirmed by initial interviews at the start of the project, is that they often lack the knowledge about which areas of a city might be the best place for them to live in.

The 'Where to Live' section aims to provide an answer to this need by allowing the user to explore the different parts of the city by means of geo-located area indicators such as “Is the area expensive?” or “Is it inhabited by young people?”

2.2.1.1.2 Finding a place

Once better informed about the city and its different areas, the user can move on to finding possible places to live. The 'Find a Place' section of the Relocation application allows the user to search and to browse through available houses and apartments for sale or rent. Apart from search criteria related to the property itself, such as its rental

price or its number of rooms, the application also allows to constrain a search result to a property's proximity to specific points of interest in the area of the property. This functionality exceeds the features of most house searching sites today.

Search results can be evaluated in detail on a separate page on which the different aspects of the property itself are described. Once again, the basic information available about a property is extended by information about the area it is located in. Points of interest (POI) of different categories are shown on a map centred near the house or flat in question. The user is able to select the POI and to display or to hide those on the map.

2.2.1.1.3 Marking favourites

Once a house or flat is evaluated by the user and being shortlisted, users can add a property to their 'favourites', a personalised list of houses or flats to be retrieved easily later again.

These favourites are made available via a separate 'My Favourites' page in the web interface (and on the mobile device). Similarly, houses added to favourites while on the road using the mobile application can be retrieved here as well as all user preferences and other user related data is stored in the cloud.

2.2.1.1.4 Living in the City

Moving to another city also involves plenty of administrative procedures as well as finding one's way across many different service providers and institutions that play one part or another in settling down. Be it knowing where the city administrative offices are, knowing more about which taxes need to be paid and other practical matters.

The "Living in the City" component bundles any resources with regards to moving to and living in the city, all together in an easy to brows overview. Potentially this component allows for direct interaction between the future citizen and the city administration or any other institution, but at the very least it serves as a hub of useful information.

2.2.1.2 The future citizen looking for a house via the mobile application

Once on the ground in the City, the user is able to use the mobile application to visit the places that were pre-selected as favourites while using the web application, find new places from within the application itself and discover the neighbourhood and its points of interest.

2.2.1.2.1 Finding a place

The user can search for properties on the phone itself using a basic set of search criteria. The mobile application connects to the cloud platform to perform the search and returns a list of properties in a way that is 'mobile friendly'.

Just like on the web interface, the user can view the details of specific properties as well as explore the points of interest in the direct vicinity of the property. After all, being able to know whether a school is nearby for one's kids or whether the nearest supermarket is easy to reach on foot, are important factors when deciding on whether a specific property is worthwhile. Just like the web interface, the mobile application exposes a wide range of POI categories, as different users have different requirements and preferences with regards to what they want to live near to.

2.2.1.2.2 What's around me?

Points of Interest are not only useful when shown around a specific property, but also when shown centred around the user him- or herself. When wandering through an unknown city, the users are able to get an idea of the area around themselves by accessing the "What's Around Me" component.

Selecting a POI category of choice shows the nearest POIs of that category *around the user*. Bus stops, pharmacies or places of religious worship: as many POI categories as are deemed useful can be integrated.

2.2.1.2.3 Accessing Favourites

Accessing one's favourites, marked while using the web component or the mobile application itself, can be done from an easy to reach list. This list is continuously kept up to date, stored on the cloud platform.

2.2.1.3 City administration, third parties and user metrics

The Relocation Service application is not only useful for those moving into another city but for the city's administration and for other stakeholders as well.

The administration, for example, might be interested in answers to the following questions: Which are the hot new areas people want to live in? What kind of houses are expats or other target groups looking for when coming into the city? Which points of interest are most important in deciding whether a place is interesting or not?

At the basis of this application usage are logs that register notable user behaviour of note. By making these logs available through services, their results can be shown to selected user roles as well as potentially used to power certain functionalities of the application itself (predictive behaviour and such).

2.2.2 Pilot Description

The Relocation pilot matched the above scenario to the city of Brussels and later to the city of Tirgu Mures.

Brussels attracts many expats from around the world each year and this target group in specific was chosen to be the focus point of the Brussels Relocation application.

2.2.2.1.1 Fine tuning requirements

Extensive user and stakeholder interviews and research at the start of the pilot resulted in a set of requirements more specific to the selected target group as well as a priority list of which features were most important to be integrated first and which could be integrated at a later stage.

This provided an internal roadmap for delivering the various planned functionalities and their forms across the planned development phases.

2.2.2.1.2 Connecting data sources and services

A major part of the pilot consisted of connecting different, third party live data sources to the cloud platform and making them accessible to the Relocation pilot applications.

On the one hand, the project partner Immoweb exposes a vast database of available housing, both for sale and for rent. On the other hand, project partner CIBG accounted

for a large database of points of interest and geo-located demographic information. Both partners adapted their services for easy consumption by the web platform.



Figure 5: Houses found using the web application

The Relocation pilot was aimed at combining these data sources in such a way that their combination provided functionality that exceeded the products their owning parties currently offer.



Figure 6: A selection of POIs around a specific house

An important aspect of connecting these data sources was taking into account the business model and other important characteristics of the data sources involved.

The pilot had been an excellent opportunity for partners like Immoweb to evaluate how data that is core to their business model, can be used in products external to their own offering and what the business implications and opportunities are for them.

2.2.2.1.3 Proving re-use

In the last phase of the project, the Relocation application built for the city of Brussels was re-adapted for use in the city of Tirgu Mures in Romania in a short amount of time, using different data sources and even integrated with new services available on the

platform. This exercise proves the reusability and transportability of the Relocation application and its underlying EPIC platform.

2.2.2.1.4 Process

Throughout the pilot, the initial development roadmap was taken as a basis for the development process and adjusted based on the user feedback gathered from the closed and open testing cycles.

2.3 Smart Environment Pilot: Energy Monitoring

This section provides an overview about the Smart Environment pilot. Again, the respective scenario description is presented first. Then, a more technical description is provided.

2.3.1 Scenario

The Smart Environment Pilot focuses on providing energy usage dashboards for citizen's homes, public buildings and commercial premises. By providing improved visibility and understanding of energy usage for citizens the city administration and owners of commercial premises can take actions to reduce energy usage. Energy billing and the resulting impact on the environment is out of scope of EPIC.

A user has to install a small (commercially available) energy monitor for gathering energy data. This comprises an inductive clamp and wireless transmitter, which must be installed at the meter or consumer unit, but does not require any direct electrical connections. The power data measured by the clamp is sent to the small display unit, which can be located in the user's house. The display is updated every 6 seconds to show instantaneous power and can cycle through daily, weekly and monthly averages. Due to storage limitations data older than 1 month is lost. An example installation of the clamp and transmitter is shown in Figure 6 with the display unit shown in Figure 7.



Figure 7: domestic Installation of Current Clamp and Wireless Transmitter



Figure 8: EnviR Display Unit and TP-Link Mini-Router Internet Bridge

The EnviR module is a standalone unit without internet connectivity, so the BCU and IBM technical teams created an internet bridge to the EPIC platform by re-flashing the firmware of a commercial TP-Link mini-router with some custom generated software and MQTT. This connects between the EnviR and the user's broadband connection and sends data to the EPIC WebSphereMQ server using the well-known IoT protocol MQTT, i.e. the quality of data received by the EPIC platform strongly depends on the broadband connection

The EPIC platform therefore receives the data from the EnviR via the TP-Link. The data are stored outside the platform in the GMF server, which subscribes to energy data updates published by the TP-Link. MQTT is a publish-subscribe or "pub-sub" protocol, where the house "publishes" energy update once every six seconds when the EnviR display is refreshed. The GMF then subscribes to these energy messages and the WebSphereMQ message broker forwards them. The overall architecture for the smart-environment pilot is shown in Figure 9 and the schematic for the domestic energy component is shown in Figure 10.

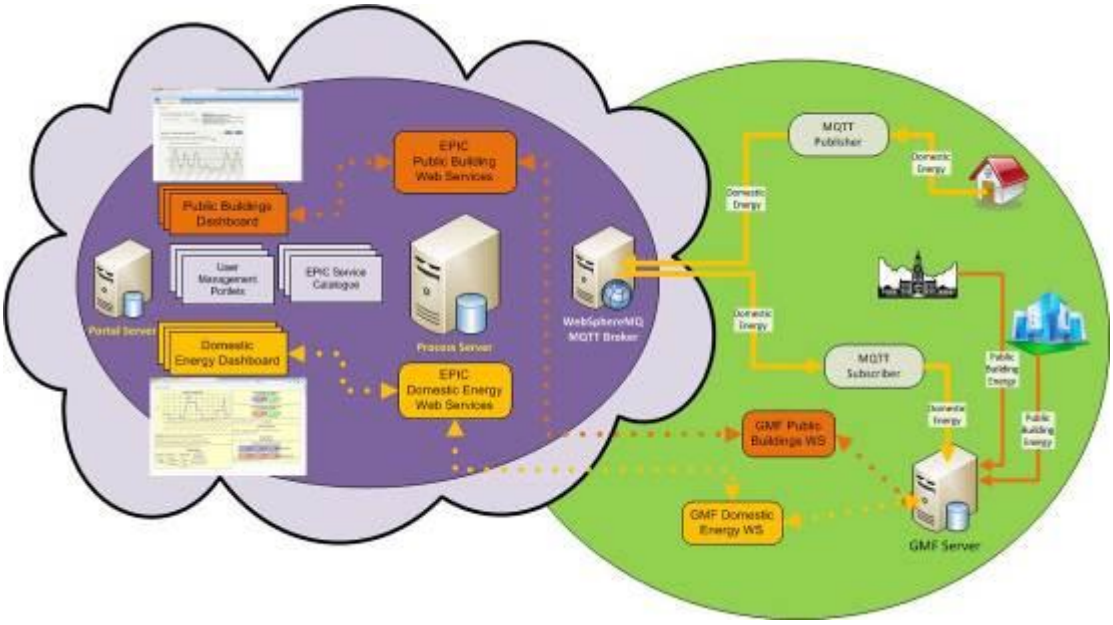


Figure 9: Architecture of EPIC Smart Environment Pilot

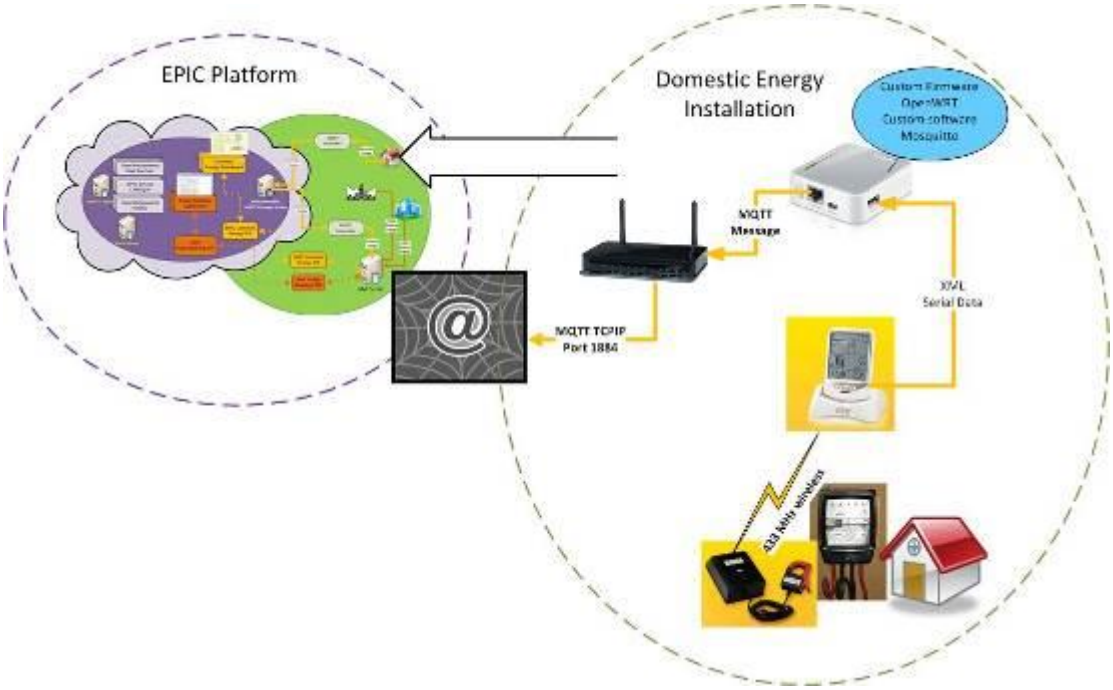


Figure 10: Schematic of Domestic Energy Element of Smart Environment

The domestic energy dashboard allows the users to view their electrical power profile and cumulative energy usage over a variety of periods from 1-hour to 90-days. The graph window shows the instantaneous power demand and displays the peaks that correspond to the use of high-load appliances such as electric kettles, electrical showers, cookers, etc. This helps the user to identify the effect of using different appliances. By entering per-unit costs for their electricity, the dashboard also provides an estimated cost of the energy usage over his display period, but this is intended only as a guide and is not a bill-estimator.

In addition to the personal power profile, the user can also view the average power profile and the average energy usage of properties of a similar type for comparison with their personal energy usage. An example screen grab of the domestic energy dashboard is shown in Figure 11. The 8 Kw load between 10:04 and 10:19 corresponds to the use of an electric shower, with an increase to 11 kW in the middle corresponding to the boiling of a kettle, adding an additional 3 Kw to the 8Kw shower loading.

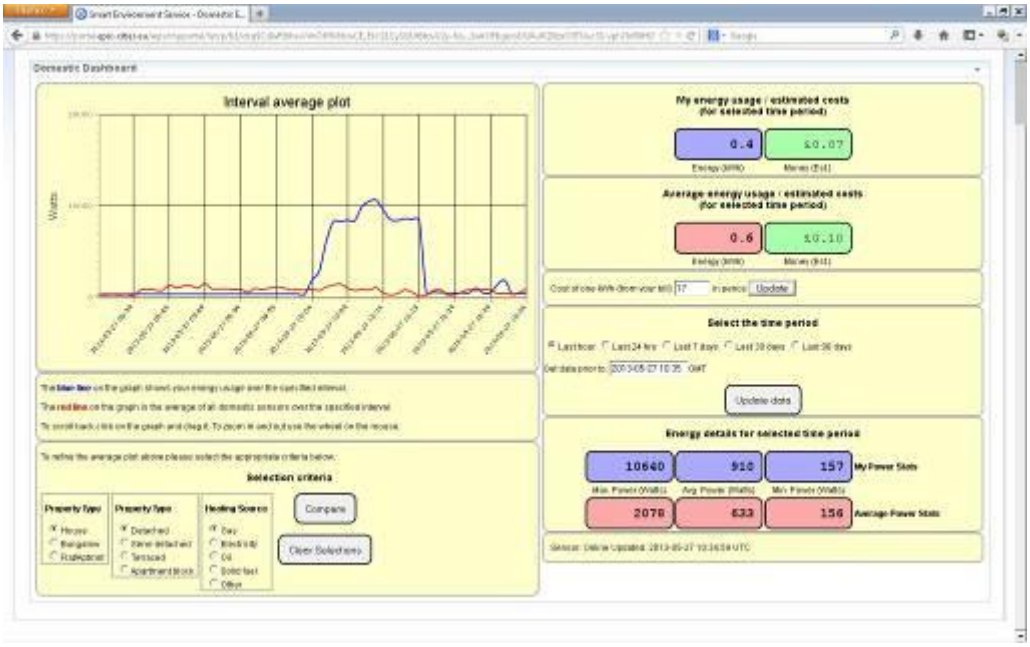


Figure 11: Example Screen Grab of Domestic Energy Dashboard

The public buildings dashboard is a separate dashboard that takes a rather different form, as shown in Figure 12.

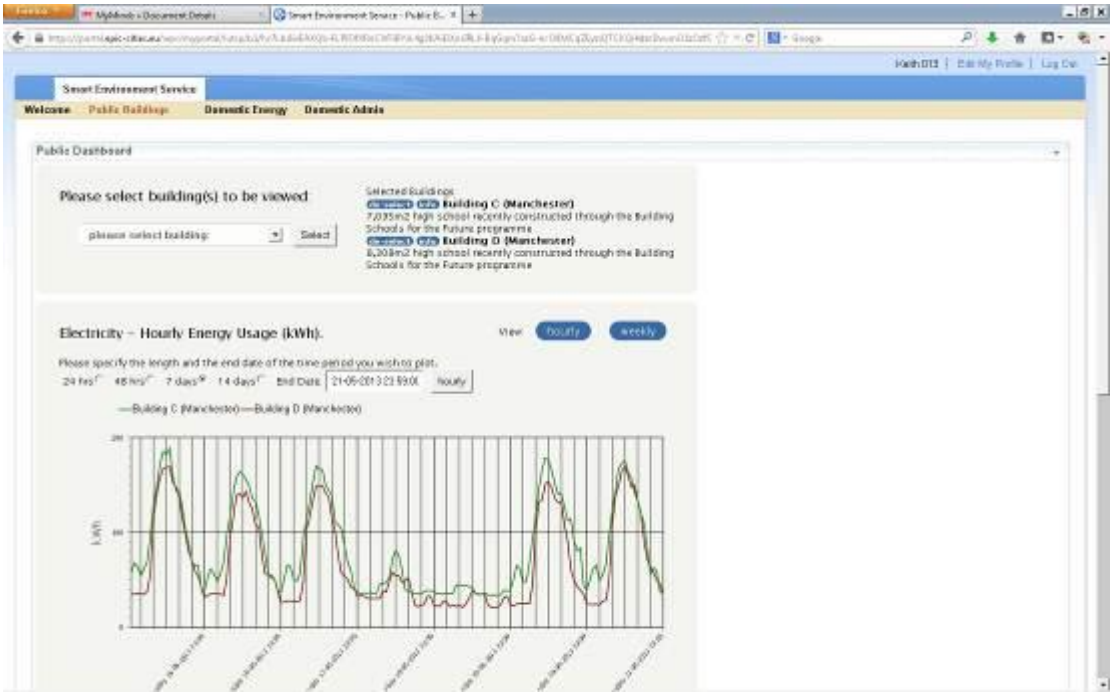


Figure 12: Example Public Building Dashboard

Although there are two discrete usages, namely domestic energy and public buildings, it is envisaged that both of these have potential application for citizens, the city administration and businesses, as explained below.

Domestic Energy Scenario 1: A citizen installs a home energy monitor, possibly provided by the city administration, a utility provider a landlord etc. or purchased by the citizen. The monitor provides an instantaneous display of energy used in their home via a small LCD display and can commonly show usage over the last 24 hours, 7 days, 30 days and 90day periods. However data is overwritten and no historic data older than 90 days is stored in the monitor. Whilst they monitor their current and historic energy consumption, the citizen has no idea how their usage compares with that of citizens in similar properties or with similar household sizes and constitutions.

The EPIC smart environment pilot allows the user to connect their monitor to the EPIC platform, so that energy data is stored off-platform for subsequent analysis. A personalised domestic energy dashboard provides an instantaneous display of power usage and a cumulative energy usage display including estimates of cost. Additionally it produces average power profile and energy usage of properties similar to those of the citizen for benchmark purposes.. The citizen's power usage is shown as a blue line of the power profile graph and the average of similar properties is shown as a red line so that users can compare their consumption with that of similar properties.

Domestic Energy Scenario 2: The city has undertaken a range of energy reduction measures in city-owned properties, including improved home insulation and has invested in some renewable technologies including installation of PV panels and solar water heating. To validate the retrofit programme and to encourage other citizens to become involved, the city needs to be able to compare the energy usage of upgraded properties with the baseline of those that have had no energy efficiency measures implemented. By issuing citizens in retrofitted and unmodified buildings with the energy-monitors and by connecting this to EPIC, the city administration can compare the average consumption of unmodified properties of a similar type with those of similar properties that have been retrofitted. Furthermore, citizens in the unmodified properties can see the energy reduction and hence reductions in utility bills enjoyed by those in the upgraded buildings and this can act as an incentive to participate. Hyper-local schemes between small groups of citizens can run small energy competitions to see who can reduce their energy usage the most.

Public Buildings Scenario 1: The City administration has embarked on a range of energy reduction measures for public buildings, including more efficient boilers, changes to the building management system schedules and upgrades to smarter LED lighting. The city wishes to demonstrate to citizens how these measures are both reducing CO2 emissions and reducing the amount of city taxes, paid for by citizens that are spent on operation of public buildings.

By feeding daily reports generated from the building management systems or the building smart-meters to the EPIC platform, citizens and the city administration staff can compare the energy usage of the building at different times, comparing the consumption before upgrades with that following upgrades. The energy usage is also provided in terms of Kg CO2, so that the direct effect of the energy saving can be readily seen by

citizens, and the reducing in utility bills for public buildings operation can be seen and related directly to city taxes paid.

The public buildings energy dashboard is visible to all citizens who choose to access it via the city homepage and is a live replacement for the building energy certificates, which are normally found in public buildings.

Public Buildings Scenario 2: The staffs in charge of operating public buildings often rely on their personal knowledge and understanding of a building, its plant and equipment and its patterns of usage. They will control the HVAC plant normally via the BMS and may have special operating procedures that they think help reduce energy use, or may be over-riding controls introduced by the BMS to save energy. The buildings operations staff in a different but similar building may have entirely different operating procedures, plants, BMS, etc. Whilst the BMS head-end gives access to all of the BMS information in a given building, it typically does not allow historic comparisons between buildings, as the BMS is primarily a control system.

By using the public buildings dashboard, buildings operations staff may compare the energy used in their building with that of similar other buildings. They may then be able to share with their equivalents in other buildings, tips and tricks for reducing energy usage. Furthermore the EPIC public buildings dashboard allows comparisons of energy used in different buildings over the same historical periods. The use of the dashboard may also enable staff to see the effects of their current BMS settings, particularly what is happening at weekend, bank-holidays and at night when the building is unoccupied.

By reusing data already available from the BMS and fiscal smart-meters, the EPIC public buildings pilot requires no additional sensors to be installed in the monitored buildings, it simply needs to gain access to the daily exports of smart-meter data that are created automatically by the BMS.

2.3.2 Technical Description

The Smart Environment pilot uses a single welcome screen to introduce both aspects of the pilot, supporting English, Romanian and Hungarian languages. Unlike the other pilots, no separate portlets were created for the Tirgu-Mures proof-of-concept but multi-language capability was added. The welcome screen for the Smart Environment Pilot is shown below in Figure 13.

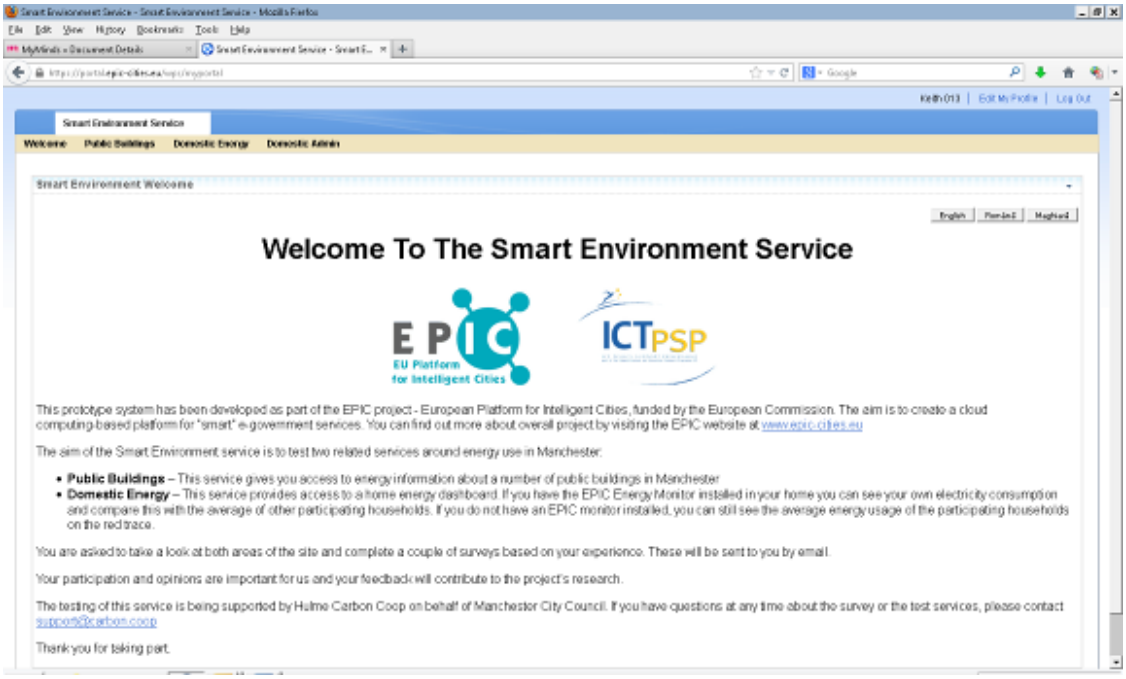


Figure 13: Smart Environment Service Welcome Screen

From the welcome screen, users can access the Domestic Energy or Public Buildings dashboards. The Domestic Admin tab is visible only to users who have administrator rights.

2.3.2.1 Citizen View: Personal Energy Dashboard

A citizen who has installed the energy monitoring hardware and connected it to their home broadband will see a personalised view of their energy usage when s/he has logged into the EPIC platform. The users' EPIC user ID is displayed with the chosen username. All citizens who have monitoring equipment must have a unique EPIC user ID and the MAC address of their energy monitor must be registered with the off-platform Generic Monitoring Framework (GMF) that handles all energy data feeds.

An example screen-grab of the domestic energy dashboard is shown below in Figure 14, with the default 1-hour view. The blue trace on the graph shows the power profile over the last hour / 24 hours / 7 days / 30 days / 90 days as selected by the user. The graph window can be scrolled and zoomed. The total energy used and the maximum and minimum power is also displayed across the time period of interest.

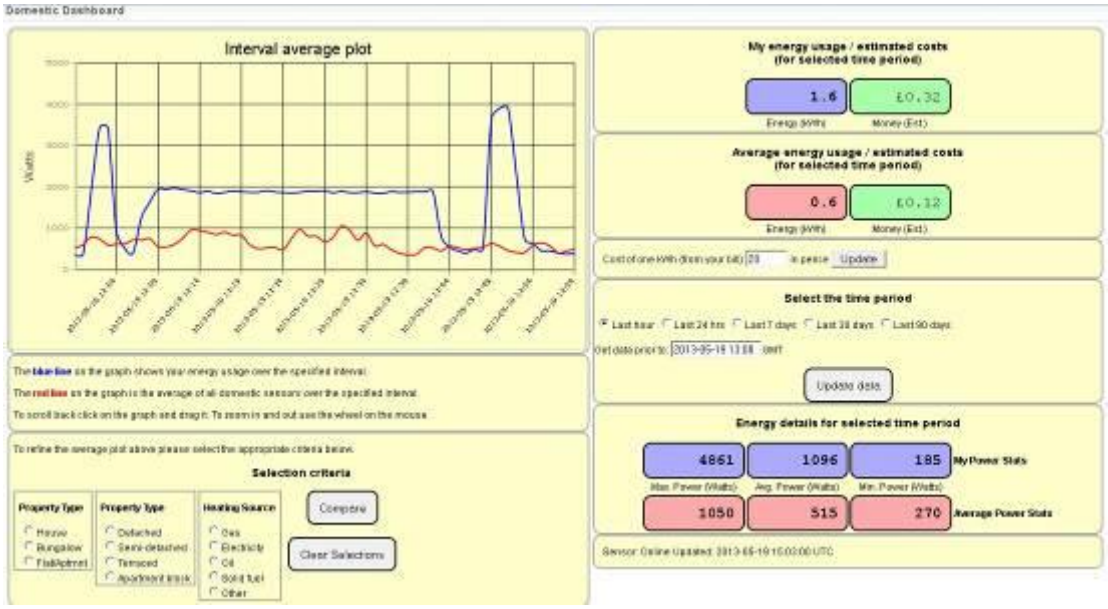


Figure 14: Default 1-hour View of Domestic Electricity Usage

The red trace on the graph initially shows an average of all monitored homes, which can be refined by the user to select a property similar to his/her own. The red trace provides a benchmark against which the user can compare their personal energy usage. The blue trace is personal to the user and cannot be viewed by other users.

A citizen who does not have an energy monitor installed will be able to access the domestic energy portlet, but the graph window will contain only the red average trace. Since there is no personal power profile available no blue trace is displayed.

The user is able to refine the red trace to match more closely their property type using the radio buttons placed under the graph window. Currently only three property parameters are recorded and these allow the average energy trace to be recalculated from all of the domestic data from similar property types by pressing the compare button. This requires real-time recalculation of the average power profile and the average energy consumed by one of the GMF web-services and is computationally intensive, with an execution time of 20-25 seconds for the 1 hour profile with up to 100 properties monitored.

The display areas to the right of the screen focus on the energy consumed over the selected period. The domestic sensors deliver a total power reading one per six seconds, to be considered in the calculation of the energy consumed. The maximum power, minimum power and average power is calculated in addition to the total energy consumed. The user can also request a cost estimate of her/his KwH charge. This is an estimate only. The EPIC domestic energy pilot was not designed to be, and cannot for a number of technical reasons, be considered as a smart billing application.
The dashboard shows the electrical power profile for the home on the blue trace in the graph window and this can be scrolled backwards in time and zoomed. The power profile results from the simultaneous use of a washing machine, and electric cooker and boiling a kettle twice. The displayed period can be selected from 1 hour to 90 days and the total energy consumed, i.e. the area under the power trace, is calculated and displayed, together with the maximum, mean and minimum power usage during the

selected period. The 24-hour view is shown in **Erreur ! Source du renvoi introuvable.** and the 7-day view is shown in Figure 16 (Figure 14 above shows the 1 hour view)

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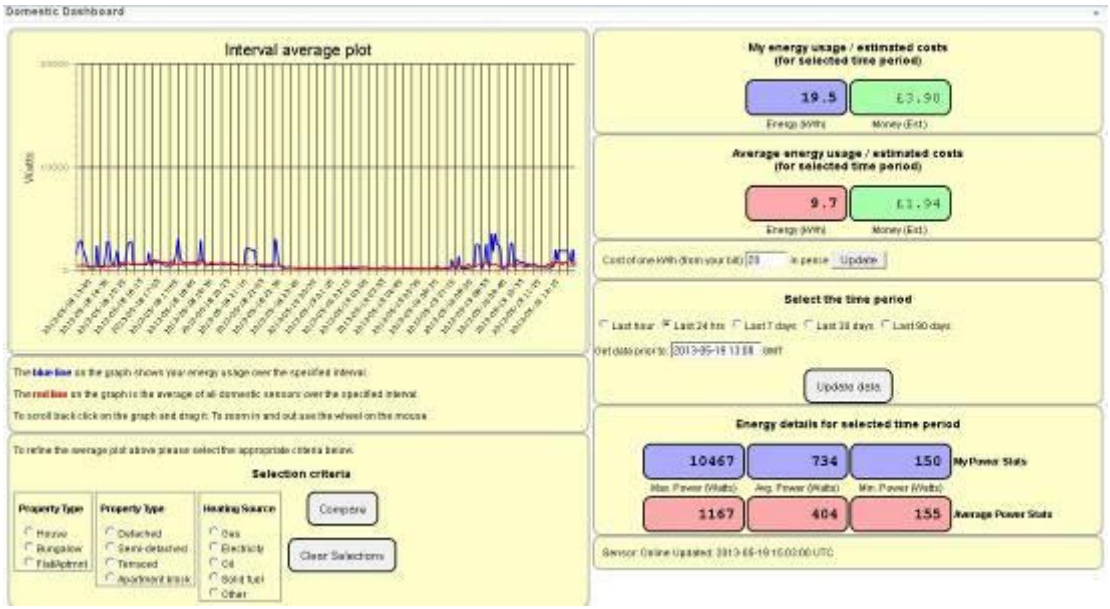


Figure 15: 24-hour View of Domestic Electricity Usage

The low power night-time demand whilst the household sleeps is clear visible between 22:30 and 05:40, when the house wakes and coffee is made (the kettle spike).

The dashboard can be used to look at any period by entry of the date and time into the time period window, either using the keyboard or by selecting the date and time from the calendar control. The selected date / time defines the right hand side of the graph window, i.e. it is the date/time from which information will be displayed backwards in time.

If the user's monitor loses connectivity at any period, there will be gaps in the blue personalised trace and clearly these are not included in the energy calculations, and are treated as null rather than zero power readings. If the MQTT broker goes offline, then all data is lost during this period and will appear as gaps in the red trace, as data will be missing for all houses. The GMF subscriber will not be receiving updates during this period.

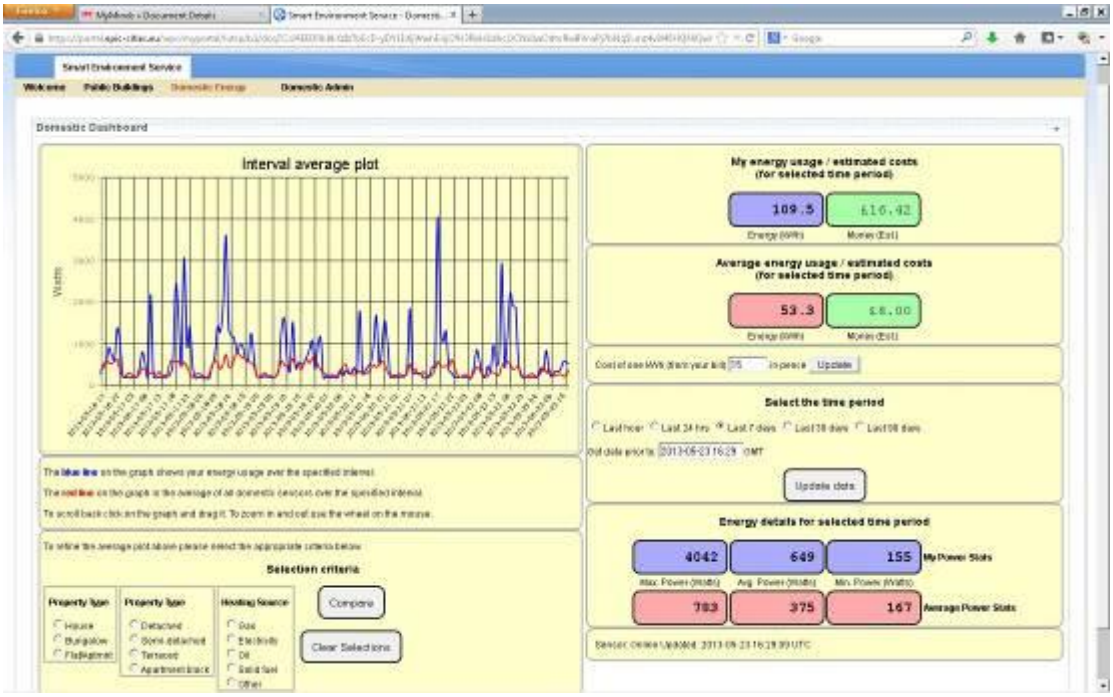


Figure 16: 7-day View of Domestic Electricity Usage

As mentioned in previous sections, the level of user interaction with the dashboard is relatively limited, being limited primarily to selection of the period for viewing to selection of property type and to the entry of estimated cost per KwH to allow costs estimates to be made.

One particular use of the domestic dashboard is to review the energy consumption of the house when it is unoccupied during the daytime or at night when the house is asleep. The quiescent energy drain of the house is associated with appliances such as fridge and freezers which switch on and off during the night by thermostat but also by other devices such as televisions, PCs, external lighting and other devices that are left in standby mode rather than switched off at night or whilst the house is unoccupied.

It is also useful to review, for example, the difference between boiling a kettle containing a single cup of water rather then filling and boiling the kettle to use only a single cup. The peak load of the kettle will still be 3 Kw, but the duration of consumption will be longer. Basically, it will use five times as much energy and cost five times as much, to boil a full 1.5 litre kettle than to boil it with only 0.3 litres in it.

2.3.2.2 Public Buildings Dashboard

The public buildings dashboard provides the same view to all smart environment pilot users, irrespective of whether they have domestic energy monitoring equipment installed. The final version of the dashboard allows the user to select from a number of monitored buildings and to overlay traces of energy consumed, again on user selected time scales. The ability to overlay multiple plots onto a single graph helps with the comparison between buildings. A small note about each building is provided but the details of location and building identification are anonymised, as a request of the building owners. An example of the public buildings dashboard is shown below:

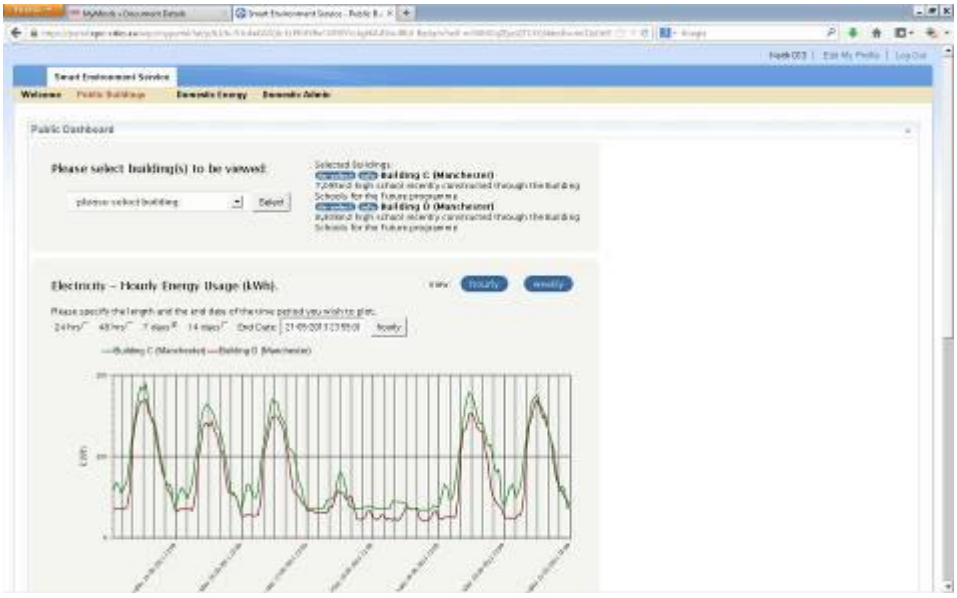


Figure 17:Public Buildings Dashboard - 7 Day View

The overlaid traces show the energy demand for each 30-minute slot of the seven day period displayed. This data is provided by the fiscal smart-meters for electricity which provide an update every 30 minutes of the energy consumed in the last 30 minutes, unlike the domestic sensors which provide every 6 seconds and update of instantaneous power demand. This is not the same type of plot as the domestic energy dashboard, as this is energy consumed with the units of KWh, not power with the units of KW. The two traces are from the two academies in Manchester, which are of similar size, yet the slightly smaller Building C, the green trace, is consuming more energy than Building D. The cyclical daily pattern of consumption is clear, where the normal operation period peaks at round midday. The 7day cycles start Wednesday far left followed by Thursday and Friday. The two consecutive very low spikes are at Saturday and Sunday respectively with less building use on Saturdays and no building use on Sundays where the buildings are closed. The data contained within the window, can be downloaded by the user for analysis.

2.3.2.3 The City View: Domestic Energy

Whilst the city has no direct interest in or access to the individual domestic energy data feeds from users, the average property data could be of interest. We envisage a scenario where a city administration has been encouraging users to invest in energy saving retrofit measures such as improved insulation and to uptake renewable energy such as photovoltaic (PV), solar water-heating and micro-generation. In such cases one of the property parameters could be the energy efficiency measure in place. This would enable the city and citizens to compare the average energy use of the retrofitted properties with that of the unmodified properties. Furthermore by collecting additional data about properties such as age; materials; household make-up, etc. it would be possible to better understand the energy use of different property types and household types.

2.3.2.4 The City View: Public Buildings

Modern public and commercial buildings typically have a building management system (BMS), responsible for all HVAC (heating, ventilation and air-condition) and for the monitoring of energy use, through fiscal smart-meters, sub-metering and other sensors. The data is typically accessed from the BMS "head-end" which allows detailed drill-down into the building controls network. Fiscal smart-meters normally send data on energy usage to the utility supplier once every 30 minutes and this data commonly also goes to third-partly analysis companies who help the city to manage carbon-budget and achieve the lowest energy supply tariffs.

The public building dashboard in smart environment is not designed to replicate the BMS functionality, but to provide a live extension to the energy certificates commonly found in public buildings. This helps a city to demonstrate to its citizens how they are achieving energy reduction, particularly by comparing between buildings or between different operating years of the same building.

2.3.2.5 Conclusions

The use of MQTT, an IoT protocol for distributed sensors, proved extremely effective, and delivered reliably the energy message sent by each domestic sensor once every six seconds, corresponding to 14,400 messages per day per home

The architecture of the GMF which sits behind the smart environment pilot has worked 100% reliably and now contains almost 30 million energy readings, mainly domestic data

The ability to visualise instantaneous power-usage and cumulative energy consumption helps households to understand their consumption, and particularly the quiescent consumption of the house when unoccupied and the effect of high-load appliances such as electric showers, kettles, electric ovens, water heaters and dishwashers. It should be emphasised that the aim of the domestic energy pilot was to help users understand energy use, not to offer a billing function.

The Public Buildings dashboard was a new deliverable not contained in the original DoW, and created by the BCU Team to broaden the applicability of smart environment to cities and businesses. The re-proposing of data-feeds available from existing fiscal smart-meters meant that no additional equipment was installed in the monitored buildings once access to data feeds has been arranged. Most BMS have a daily reporting function and this was used to create a daily report which was emailed to BCU with a data attachment. This was automatically processed, extracted and inserted into the GMF.

The re-purposing of domestic hardware to perform 3-phase monitoring for commercial premises in T-M but then processing via a smart web-service the 6-second power data to create the 30-minute energy data typical of fiscal smart-meters demonstrated the power of web-services to present data in a consistent form irrespective of the original data source.

One on-going issue was the stability of domestic broadband connections that could lead to periods of connectivity loss and consequent data loss. In extreme cases this needs rebooting of the domestic router to remedy, but the users need to be alerted to the problem. Whilst the latest versions of the custom firmware created for the TP-Links handles most connection loss transparently and automatically re-established a connection to the MQTT server, it cannot reboot the user's router if this is required.

3 Technical Adaptation Rules and Criteria

3.1 Urban Planning

To access the application go to https://portal.epic-cities.eu/wps/myportal. It is necessary to have first an account and a password.

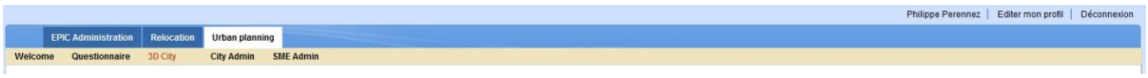


Figure 18: Screenshot of EPIC screen for accessing the "3D City"

To access features available within EPIC it is necessary to have a profile set defining access rights:

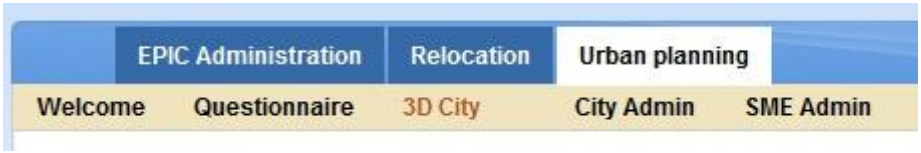
- EPIC Administrator: EPIC level to manage rights and profiles
- City Administrator: City Level to manage all content and media
- SME Administrator: SME Level to manage all content and media

On the top right the user name is displayed, an access to the user information and the ability to disconnect.



Then clicking on "Urban Planning" tabs gives access to different information:

- Welcome - Presentation of the Application and Contact
- Questionnaire - Access to the survey
- 3D City - Access to the 3D Application
- City Admin - Access to the city administrative tool for managing CITY content
- EMS Admin - Access to the administrative tool for managing SME content



At the bottom left of the page there are two tabs to access the FAQ and online help

3.1.1 Prototype Phase 1

Three essential features were originally proposed to be part of the first test phase:

- Provide the ability to navigate easily with a mouse in the 3D model of the city and access to first level of information
- Display POIs of the city through defining categories and access to detailed information via a media centre. The contents are manageable by the city meaning Media Centre and can be enriched by new information and media.
- Represent the time evolution of the city on a yearly basis with its urban projects



Figure 19: Screenshot of "Leasure and Culture"

We proposed for the first phase and the city of Issy-les-Moulineaux 4 thematic layers:

- Discover the city: ten key points with information via a media centre (text, photos and web link)
- Leisure and Culture: Cultural centres like the museum, recreational places like the library and sporting activities such as the stadium of the city with the information via a media centre (text, photos and web link) and a code of colour to differentiate them.
- Sustainability: The commitments of Agenda 21 projects with the information via a media centre (text, photos and web link) and a code of colour to differentiate flagship projects.
- Urban Projects: All urban projects that have changed the face of the city of Issy-les-Moulineaux over 30 years with a "time line" to scroll through the years and see the projects emerging from the territory.
- Economic: All SMEs installed on the territory of Issy-les-Moulineaux

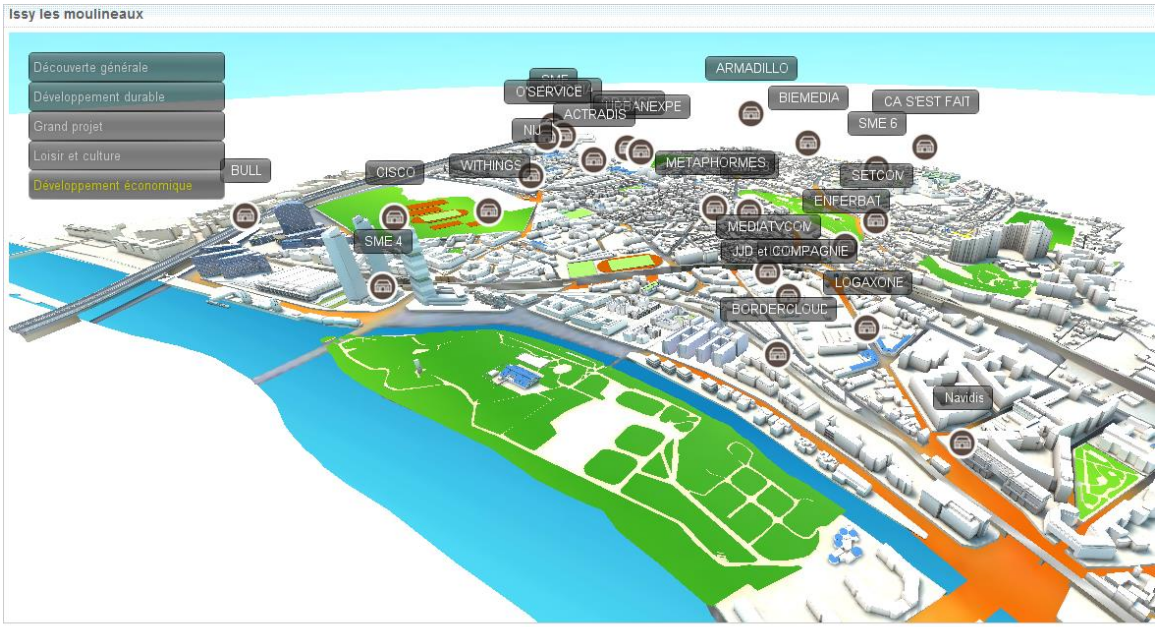


Figure 20:Screenshot of "Economic develoment"

Result of tests of the phase 1

There are in-depth results presented in D7.3, however regarding the ease of use and usefulness, users appreciate the design and immersible approach, interaction and access to information, the thematic organisation by layers. Some weaknesses have risen about how to operate with the mouse and the PAD and that the features proposed to SMEs are not at the expected level.

	Negative aspects	Positive aspects	Recommendations
Technical performance	Time for loading the 3D model is a bit long	Fluidity in navigation	Improve loading performance and access to rich media
Functionality	Unclear/lack of instructions Learning curve SMEs layer missing	Navigation is easy Access to content	Provide guidance (Help file)
Lay-out/display		Design; 3D Model Concept & layers	Add compass Display main labels (not only on rollover)
Content	Not enough city content SME contents are missing	Strong "potentiel" for development of services	- Add Layers, Content & Services (Search) - Add functionality to administration tools - Add information board with city news
Other	Need a mouse		Navigation alternative MiniMap

Improvement plan for the phase 2, based on initial objectives and feedback got from users:

- Improve performance
- Enhanced design where it is required
- Enrich the solution in adding contents like media, web link, PDF
- Extend the administration tools of contents and services
- Add SME Network functionalities

3.1.2 Prototype Phase 2

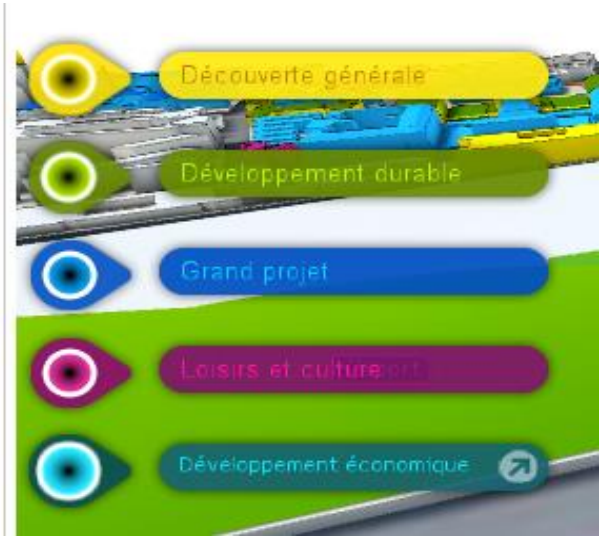
Then for the second phase of test we have improved the loading time of the application, revisited the overall design of the application, provided a new interface to access information, improved the additional information layer to enable the City understand its economy and individual SMEs that are on its territory. We now allow registered SMEs to communicate via the EPIC platform. They are able to manage by themselves their own Media Centre in providing information as the market they address, the skills they have, job opportunities offered and their "tweeter" information.

The 3D model and selection interfaces have been improved:



Figure 21:Screenshot of 3D City interface

The layers are accessible via buttons that activate when selected:



- Discover the city
- Sustainable Development
- Urban Projects
- Leisure and Culture
- Economic development

Figure 22:Layers selection

Companies are categorized for an easy searching and a better understanding of the mapping. For this we use the "Issy Spot" service that is "Open Data":



Communication
Engineering & TIC
Electronic
Events
Print
Software development
Marketing research
Television
Newspaper and press
Advertising
Telecom

Figure 23: SME Categories selection

A timeline allows moving in time to see the evolution of the area on a yearly basis (dated POI).



Figure 24: Urban Projects - The City in 1960



Figure 25:Urban Projects – The City in 2020

Media centre is used to provide additional information to the POIs and projects with description and photos: the contents of these media centres are managed in using the "City admin" tool that allows adding, deleting or changing the contents.



Figure 26:Urban Projects – Media Centre managed by the City Administrator

Media centre are also added to provide additional information to the POI and projects with description and photos: the contents of these media centres are managed in using the "SME admin" tool that allows adding, deleting or changing the name, description, skills, job opportunities, and photo. They also can display PDF supplement and the tweeter content of the company.

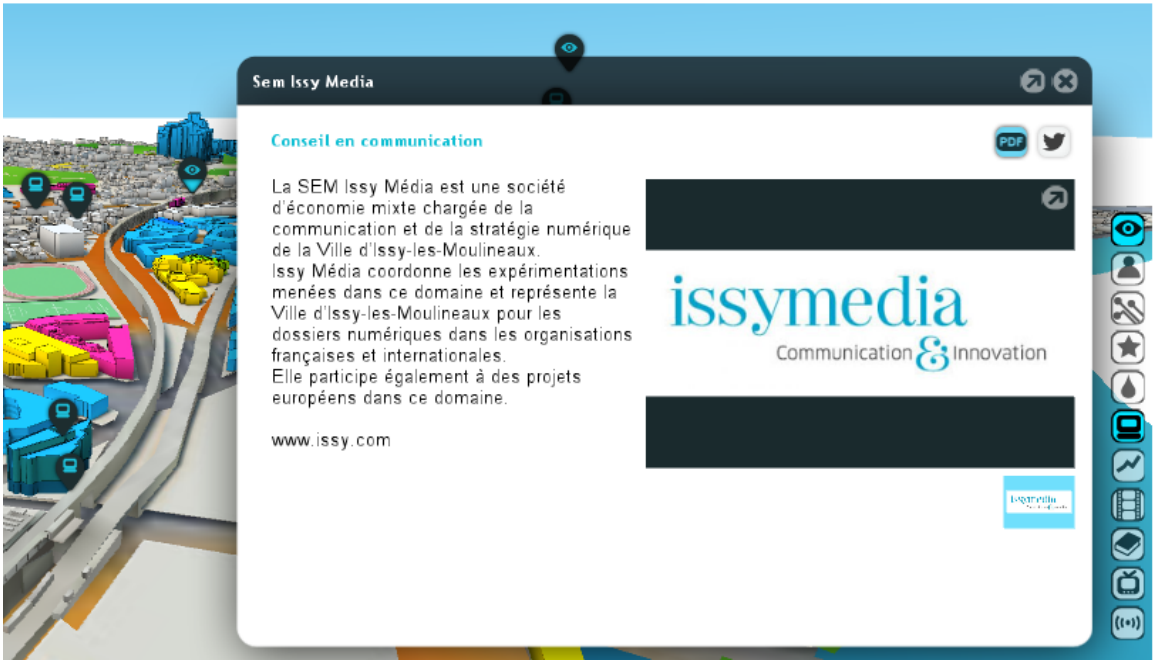


Figure 27: SME Media Center managed by the SME Administrator

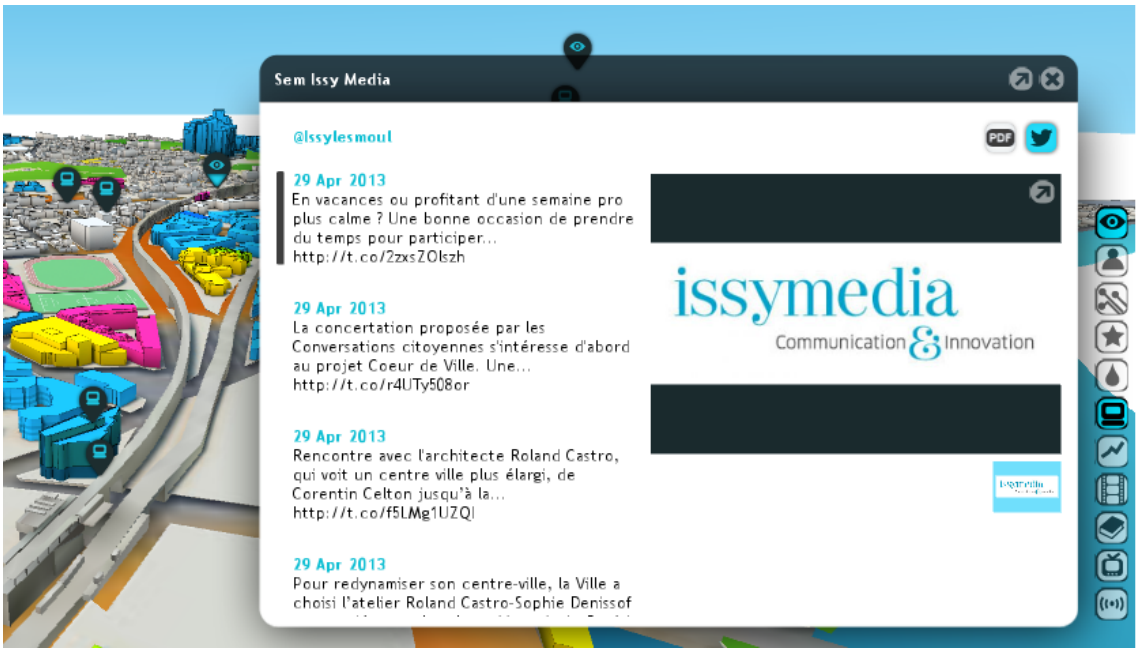


Figure 28: SME Twitter in Media Centre

RESULTS OF TESTS OF PHASE 2:

There are in-depth results presented in D7.3; however we can clearly identify the progress made from the phase 1 to the phase 2, especially on design, ergonomic, rich content and administrative tool. Still some progress is expected for SMEs.

As reminder here are tests running in two cycles

	Cycle 1	**Cycle 2**
Who	City Admin & End Users	City Admin & End Users & SMEs
What	- Explore the 3D model of the city and the proposed contents through media centers Select 1 to 4 layers: • Discover the city through major POI • Sustainable development • Urban Projects • Leasure and Culture - City Admin Tab : • Enrich and Change contents of POIs	- Add SMEs layer - Geo Tag & content - Tweeter window
Scenarios	- Visit of the city of Issy les Molineaux without any specific guidance	- 6 specific tests - Choose at least 2
External links	Survey	Survey & Specific Tests

These results mean that the effort to review the design, the interfaces and interactions, the improvement of some features like “categories”, “layers” and the administrative tool have been appreciated by users and have made the difference with the phase 1.

- **COMMUNICATION:** playfulness, very functional, very practical and fun. Another way to discover the city and an effective communication tool for the city, businesses and associations is available now. And by the way there is a high potential of development for this application, so many additional possibilities and features can be added.
- **NAVIGATION:** Good fluidity in navigation, good ergonomics, nice and easy to use and very intuitive back office for updating contents. Overall, it is easy to understand and use the 3D map. The bright colours give a dynamic aspect and make the navigation pleasant. On the other hand, the concept is perceived as innovative and very useful for both local residents, businesses or simply any entity / person who want discover the territory of Issy-les-Moulineaux.
- **3D:** 3D materialization is very useful, interesting and beautiful. It is a very good idea to make a 3D map easy to use with five relevant themes representing all important aspects of the city.
- **CONTENT:** Very good point to access points of interest and contents by layers. It is very interesting having windows to access detailed information when the content is there. Beautiful application with interesting visibility at first level even if would be great having access to more details in clicking on websites or other things. It is interesting to see urban projects in past, present and future. Using colours by theme allow easy spotting and photos are a must to keep and complete in next steps.

Nevertheless, improvements and additional features are still awaited. Some are justified and some others not.

- **ACCESS:** This application should be accessible to a maximum number of people. So, there is the question whether it should also be provided through touch tablets or smart phones?
- **NAVIGATION:** A bit difficult moving around a specific point and it is not possible to move at street level, is it planned?
- **SEARCH:** This is a very important, crucial feature such as the search is missing. It is essential to implement a search to look for a site, an enterprise, specific information and then to move the “camera” point of view focuses on the result.
- **CONTENT:** The readability of text and photos (add website, videos & 360°) should be improved, sometimes too small. City and SMEs should provide contents to this application for making it useful. Perhaps it can be improved in connecting more “Open Data” and existing media (like Issy TV, Issy website, etc.) so that the content is updated regularly and automatically. What about the contents provided through 2D maps like urban plan permissions, history if Issy-les-Moulineaux, Sustainable Development initiatives, etc.? It would be great having a collaborative

layer, allowing citizens sharing information caught in the city with a smartphone for example.

- **COMPANIES:** Enterprises should be encouraged to use the application, updating contents, sharing information and provide news toward citizen and city.

3.1.3 Prototype Phase 3 – Proof of Concept

This phase consists in repeating the experience of our different pilots with Tirgu Mures to show how it works for a City from scratch and define it as "proof of concept" and add the “Integrated scenario”, meaning we add the management of “Energy” and “Real Estate” from other pilots.

From the GIS and heights of buildings provided by our customer we have developed a 3D model of the city in LOD1 to which were added some famous places modelled in LOD2.

We defined with the city administration the interface to be in line with thematic and categorized POIs that they would like to highlight within the Urban Plan Solution.

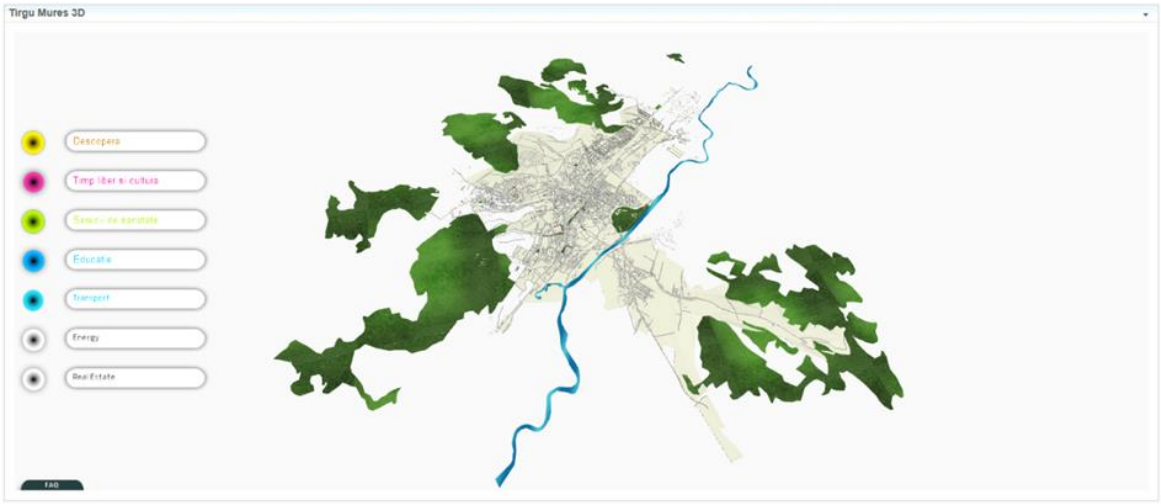


Figure 29: TM 3D City screen shot



Figure 30: TM 3D City – Categories on Discovery layer

We had access to the database of POIs built by the city via the adhoc web service and we have geo-tagged them on the 3D map by categories

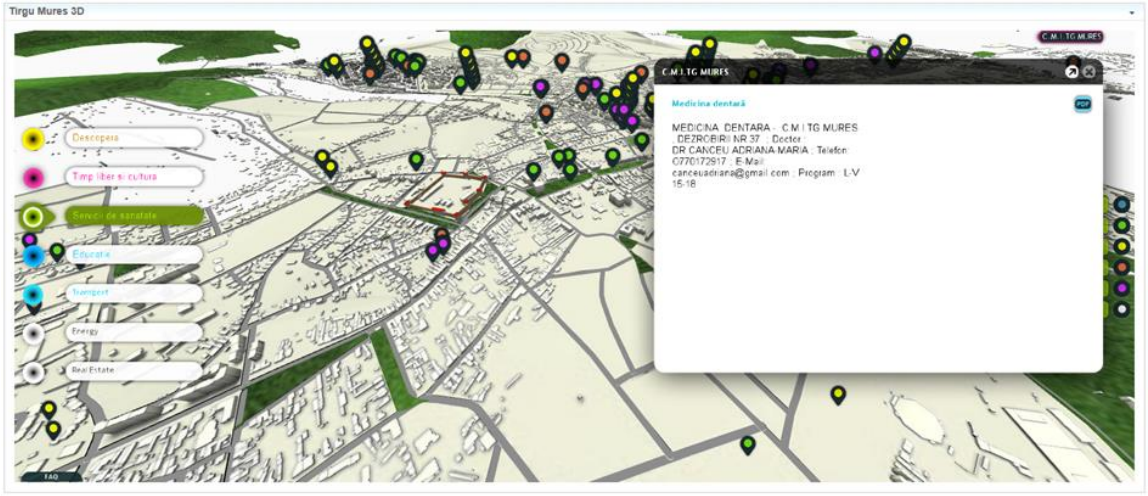


Figure 31: TM 3D City – Media Centre

In the same way we have used the Energy web service to show energy consumption of some public buildings in real time.

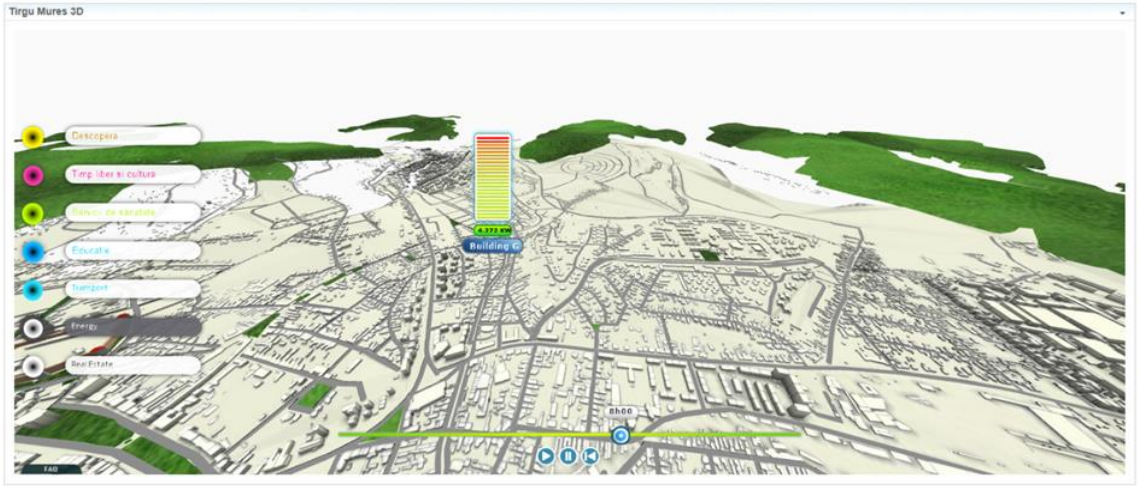


Figure 32:TM 3D City – Energy consumption display

And in using the TM Properties Web Service, we display the information of real estates.

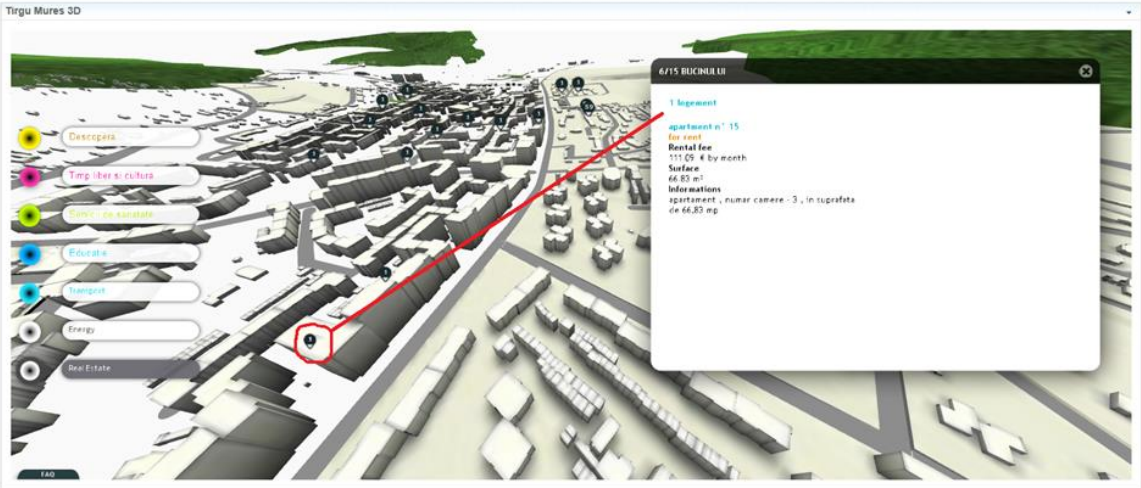


Figure 33:TM 3D City – Real Estate POI & Media Centre

RESULTS OF TESTS:

The testers were a bit disappointed by the LOD1 3D model when they expected more details with realistic view that was not in the offering.

They again complain about the loading time… it is our main issue with our V2 framework that should be partially solved with the V4 framework.

Some testers mentioned the difficulty, somewhat slow, to zoom and moving around a specific house, meaning we have to improve the move control with the mouse and the PAD. This is due to the dimension of the territory on which we propose to navigate.

POIs content is succinct and provides few information

Regarding the "integration" of energy, the question is about what the meter actually means in the city context. On which we agree, because we don't have any other indication like Country, City energy consumption for comparison.

WEAKNESSES

MAJOR ONES (MUST HAVE)

- IMPROVING LOADING TIME IS STILL REQUIRED
- SEARCH IS MISSING AND REQUESTED
- NAVIGATION NOT EASY ESPECIALLY WHEN MOVING BACK

MINOR ONES (NICE TO HAVE)

- BUTTON TO RETURN TO THE STARTING POINT IS MISSING
- INTEGRATION OF SUN LIGHT IS REQUESTED
- PHOTO OR VIDEO MAPPING ON WALL IS REQUESTED
- SOME ASSISTANCE ARE MISSING LIKE NORTH, STREET NAME, BUILDING NAMES, ETC

SOME IMPROVEMENTS ARE REQUESTED WITH THE MEDIA CENTER

- MC WINDOW REQUIRE HIGHER FORMAT
- PDF DOES NOT WORK
- HYPERTEXT & LINKS DO NOT WORK IN TEXTS
- MUST BE ABLE TO BE MOVED

- DISPLAY VIDEO AND 360 VIRTUAL TOUR ARE MISSING
- TWITTER ONLY AVAILABLE FOR BUSINESS, MISSING FOR OTHERS

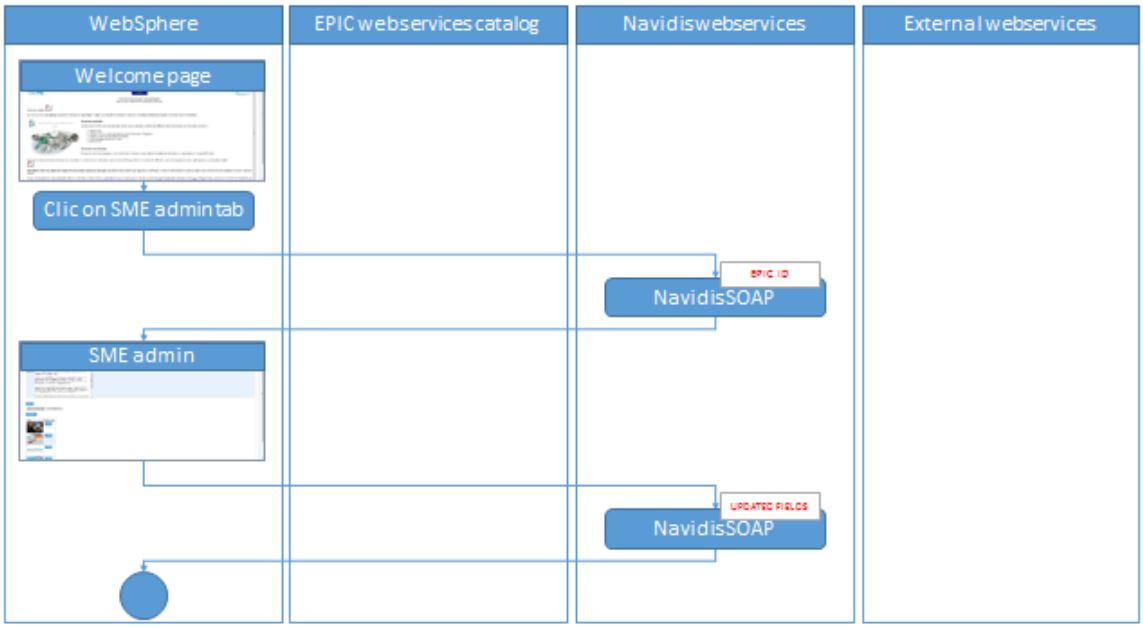
SOME IMPROVEMENTS ARE REQUESTED WITH THEMATIC

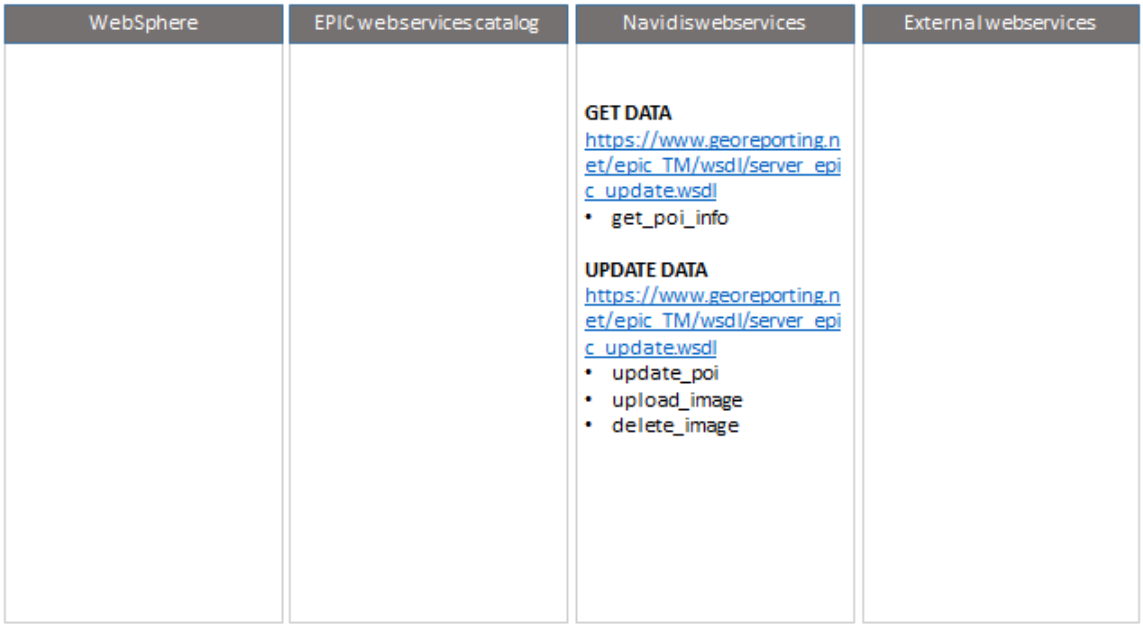
- SUSTAINABLE DEVELOPMENT CONTENT MISSING
- ECONOMIC BUBBLES OVER EACH OTHER MAKING SOME NOT READABLE
- LACK OF URBAN PROJECTS TIMELINE (CONTENT NOT AVAILABLE)

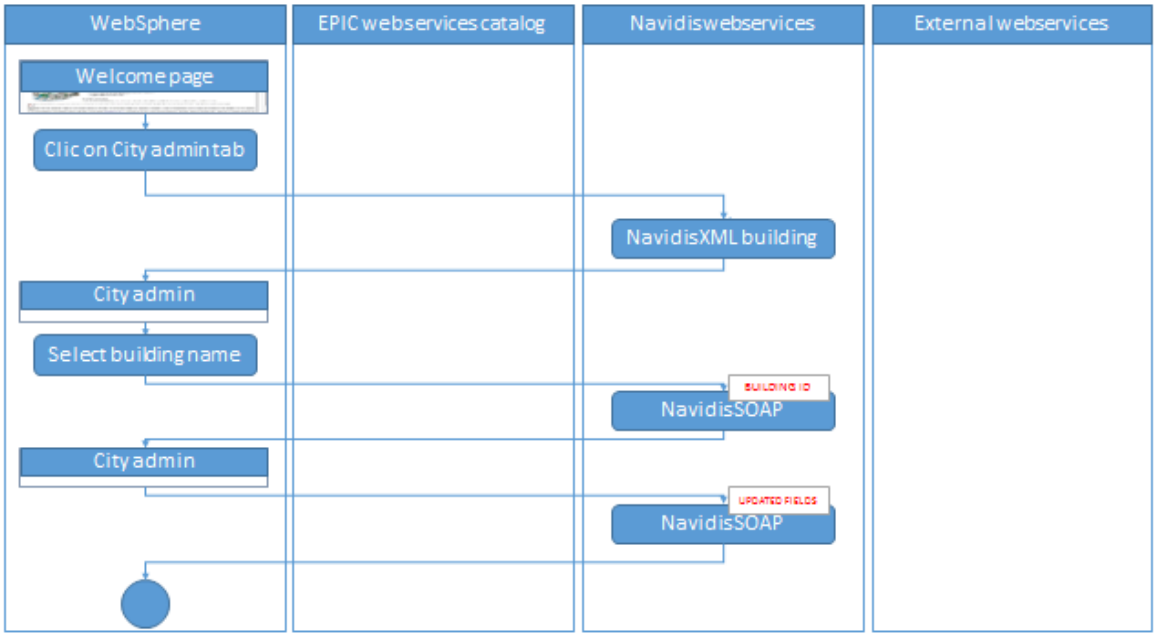
ALL THESE REQUIREMENTS ARE SET OR SOLVED WITH THE LAST VERSION OF NAVIDIS FRAMEWORK WHICH IS THE V5, WHEN THE PROTOTYPE HAS BEEN DONE WITH THE V2.

HOW 3D CITY WORKS FOR TM AND WHICH WEB SERVICES ARE USED FOR TM:

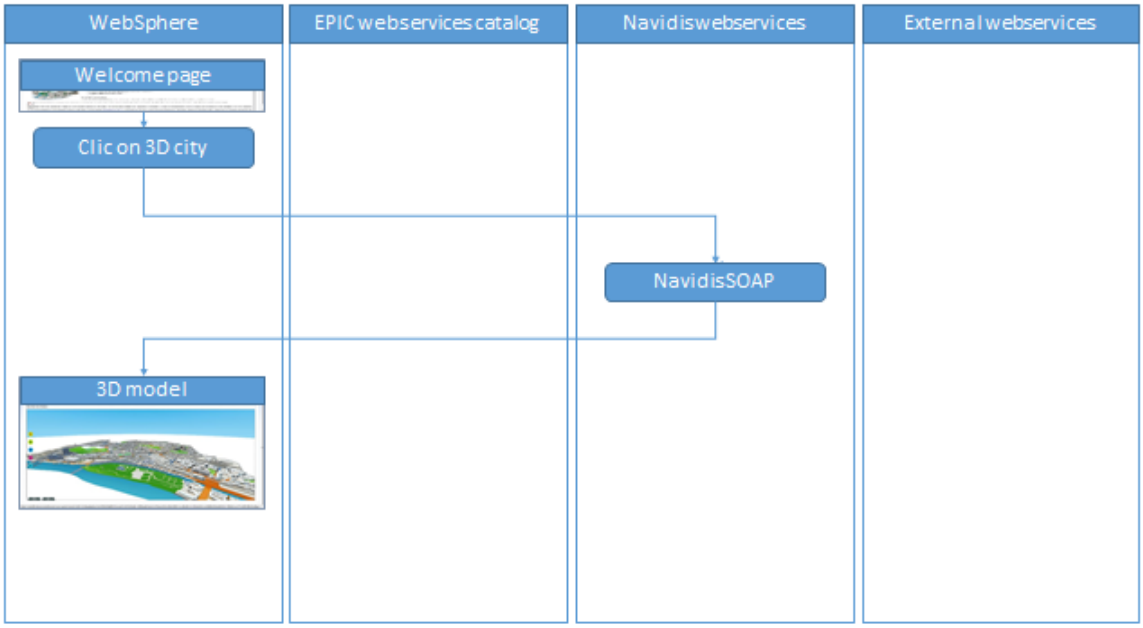
The purpose now is to highlight the web services used by the Urban Plan application and differentiate those available from the Service Catalogue, Navidis and others. E.G. customers are managed through the EPIC Web Services Catalogue.



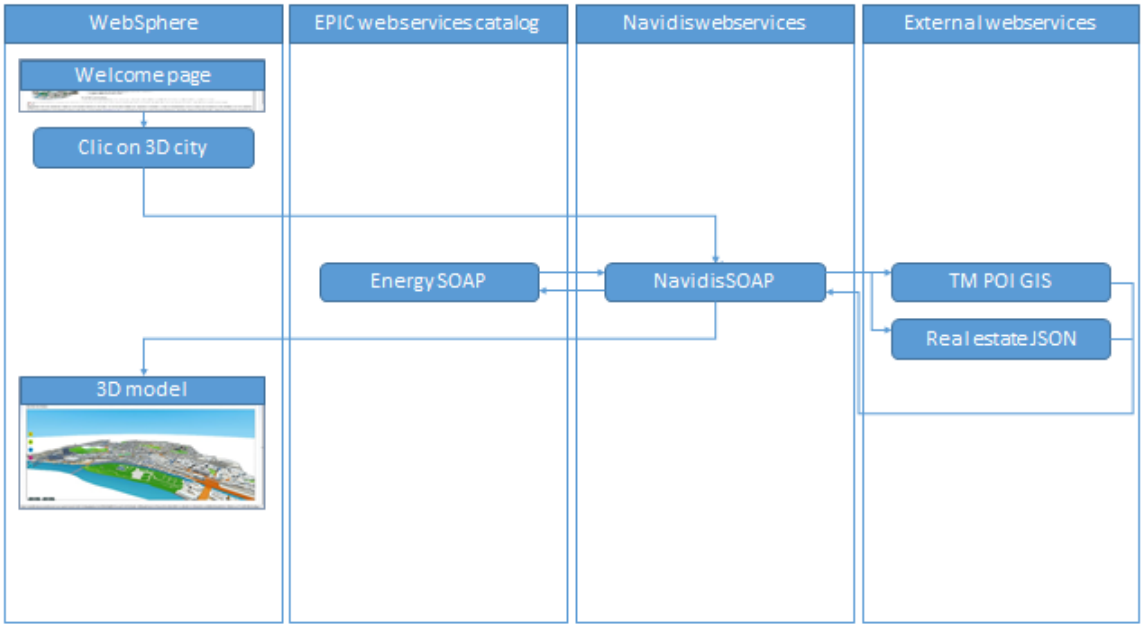




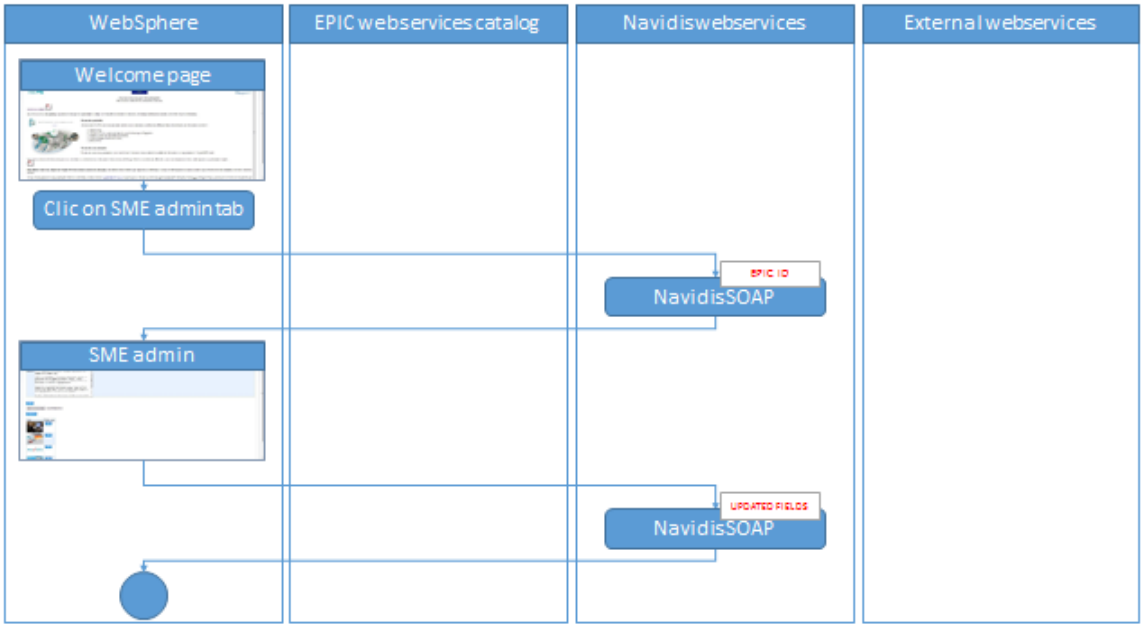
WebSphere	EPIC webservices catalog	Navidis webservices	External webservices
		OBJECTS LIST https://www.georeporting.net/epic/webservices_epic_xml.php?XML=listObjet **GET DATA** https://www.georeporting.net/epic/wsdl/server_epic_update.wsdl • get_poi_info **UPDATE DATA** https://www.georeporting.net/epic/wsdl/server_epic_update.wsdl • update_poi • upload_image • delete_image	



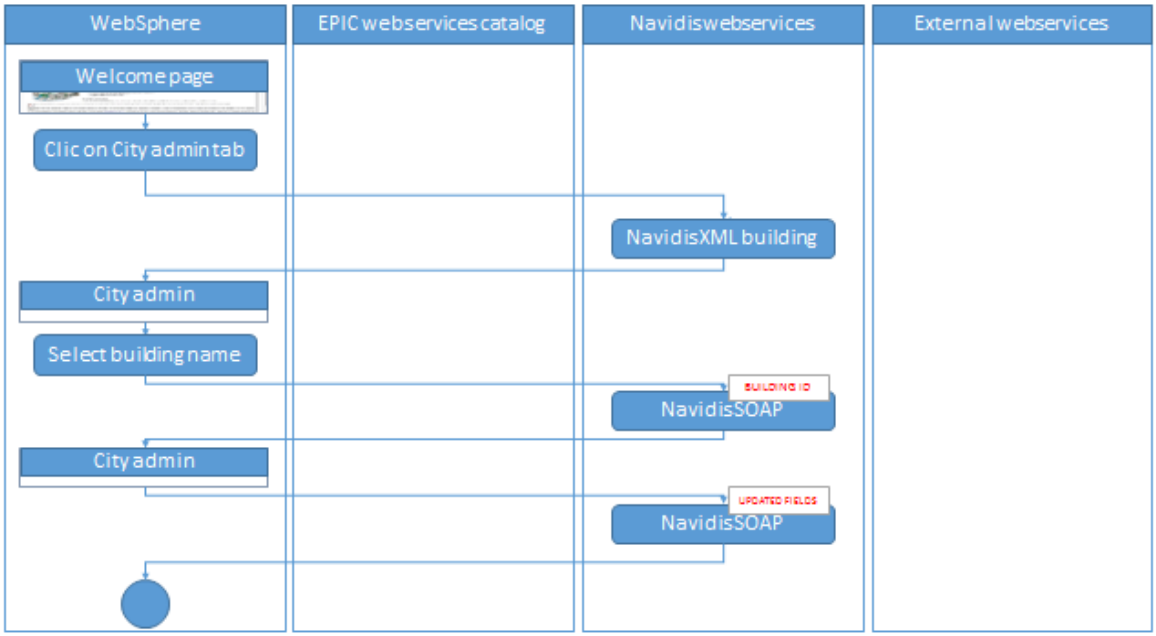
WebSphere	EPIC webservices catalog	Navidis webservices	External webservices
		GET DATA https://www.georeporting.net/epic/wsdl/server_epic.wsdl • xml_App_Interface • xml_App_Components • xml_App_Content • xml_App_Behaviour • xml_App_Style • xml_Interface • xml_Components • xml_Content • xml_Behaviour • xml_Style • xml_MediaCenter_Interface • xml_MediaCenter_Content • xml_MediaCenter_Style • xml_MediaCenter_Behaviour	



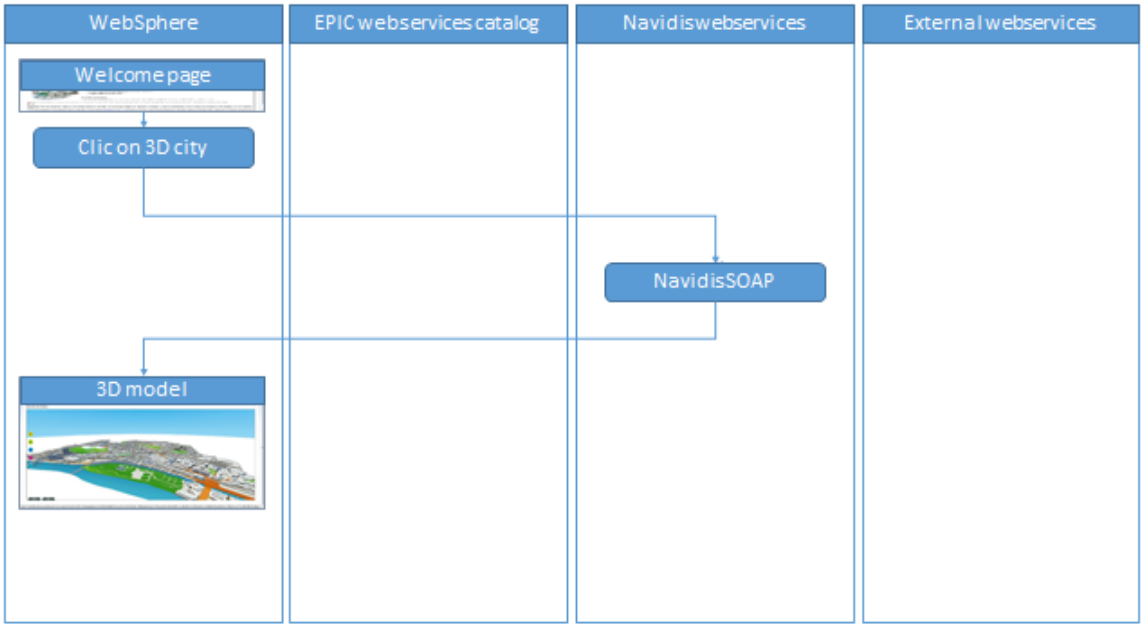
WebSphere	EPIC webservices catalog	Navidis webservices	External webservices
	GET DATA https://portal.epic-cities.eu/BCU_EPIC/BCU_GMF_SOAPWS/WEB-INF/wsdl/BCUGMFSOAPWS.wsdl • getHourlySensorDataOverRange	**GET DATA** https://www.georeporting.net/epic_TM/wsdl/server_epic.wsdl • xml_App_Interface • xml_App_Components • xml_App_Content • xml_App_Behaviour • xml_App_Style • xml_Interface • xml_Components • xml_Content • xml_Behaviour • xml_Style • xml_MediaCenter_Interface • xml_MediaCenter_Content • xml_MediaCenter_Style • xml_MediaCenter_Behaviour	**GET POI DATA** http://tirgumures.ro/hartagis/geoserver/wfs?version=1.0.0&request=GetFeature&srsName=EPSG:4326&typeName=pmmures:v_poi&outputFormat=JSON **GET Real Estate DATA** http://82.79.76.7/relocation/locativa_service.php



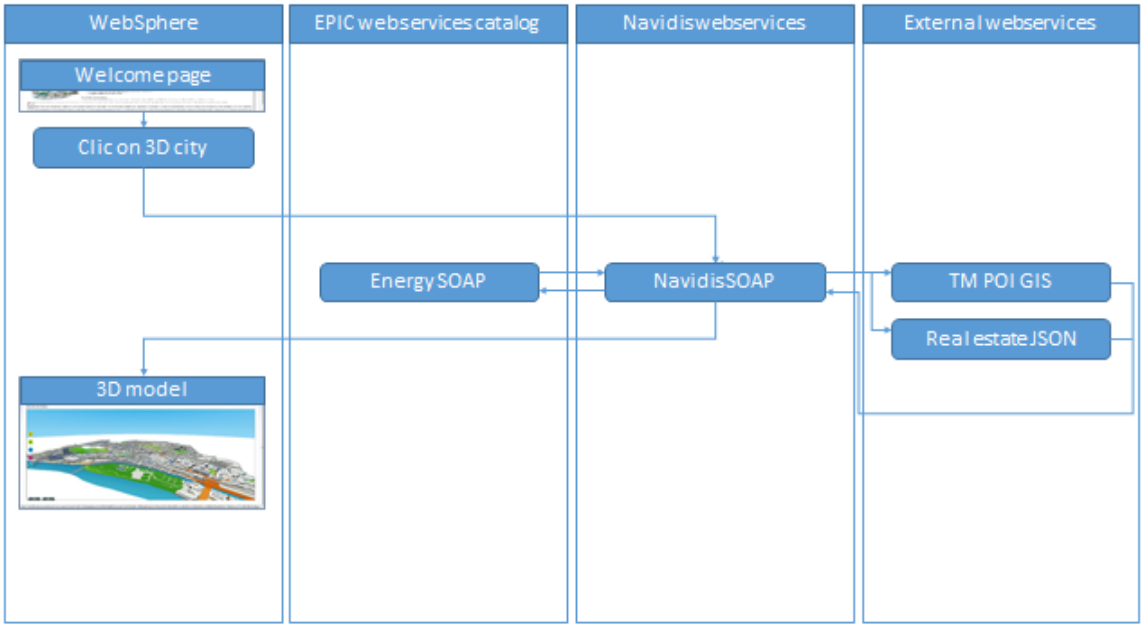
WebSphere	EPIC webservices catalog	Navidis webservices	External webservices
		GET DATA https://www.georeporting.net/epic_TM/wsdl/server_epic_update.wsdl • get_poi_info **UPDATE DATA** https://www.georeporting.net/epic_TM/wsdl/server_epic_update.wsdl • update_poi • upload_image • delete_image	



WebSphere	EPIC webservices catalog	Navidiswebservices	External webservices
		OBJECTS LIST https://www.georeporting.net/epic/webservices_epic_xml.php?XML=listObjet **GET DATA** https://www.georeporting.net/epic/wsdl/server_epic_update.wsdl • get_poi_info **UPDATE DATA** https://www.georeporting.net/epic/wsdl/server_epic_update.wsdl • update_poi • upload_image • delete_image	



WebSphere	EPIC webservices catalog	Navidis webservices	External webservices
		GET DATA https://www.georeporting.net/epic/wsdl/server_epic.wsdl • xml_App_Interface • xml_App_Components • xml_App_Content • xml_App_Behaviour • xml_App_Style • xml_Interface • xml_Components • xml_Content • xml_Behaviour • xml_Style • xml_MediaCenter_Interface • xml_MediaCenter_Content • xml_MediaCenter_Style • xml_MediaCenter_Behaviour	



WebSphere	EPIC webservices catalog	Navidis webservices	External webservices
	GET DATA https://portal.epic-cities.eu/BCU_EPIC/BCU_GMF_SOAPWS/WEB-INF/wsdl/BCUGMFSOAPWS.wsdl • getHourlySensorDataOverRange	**GET DATA** https://www.georeporting.net/epic_TM/wsdl/server_epic.wsdl • xml_App_Interface • xml_App_Components • xml_App_Content • xml_App_Behaviour • xml_App_Style • xml_Interface • xml_Components • xml_Content • xml_Behaviour • xml_Style • xml_MediaCenter_Interface • xml_MediaCenter_Content • xml_MediaCenter_Style • xml_MediaCenter_Behaviour	**GET POI DATA** http://tirgumures.ro/hartagis/geoserver/wfs?version=1.0.0&request=GetFeature&srsName=EPSG:4326&typeName=pmmures:v_poi&outputFormat=JSON **GET Real Estate DATA** http://82.79.76.7/relocation/locativa_service.php

3.2 Relocation

3.2.1 Accessing the Brussels Relocation Application and Tirgu Mures Relocation Application

In order to access the web components of these applications a valid EPIC user ID with the proper roles to either access the Brussels Relocation Application or Tirgu Mures Relocation application is required.

Such a user can login on the platform via the following link:

https://portal.epic-cities.eu/wps/portal

Once logged in, the Brussels Relocation Pilot can be accessed through the tab 'Relocation' whereas the Tirgu Mures Relocation Pilot can be accessed through the tab 'Find a House' or its Romanian or Hungarian translation if the user has set any of these languages in his or her user preferences.

3.2.2 Relocation Pilot Test Phases

The Relocation pilot was developed and tested throughout a number of cycles. Two closed group cycles focused on the core functionality of the applications and 4 open group testing cycles expanded on this functionality. The test cycles helped to evaluate the planned functionalities for the applications as well as enable the gathering of new ideas and prioritization of features to follow in upcoming cycles.

The Relocation Pilot culminated in a series of tests in Tirgu Mures, after adapting the applications to this new city.

3.2.2.1 Closed Group - Cycle 1

The period running up to this very first phase saw the major groundwork for the entire Relocation Pilot be performed, resulting in a first set of critical features.

3.2.2.1.1 Functionalities for this phase

- Search for properties based on basic criteria such as for sale/rent, housing type, price and postal code.
- Display search results in a list and on a map
- Display a property's basic details on a separate page
- Show a first set of points of interest
- Save a selected property as a favourite
- Retrieve a selected property marked as a favourite
- Log key user activities within the EPIC relocation application

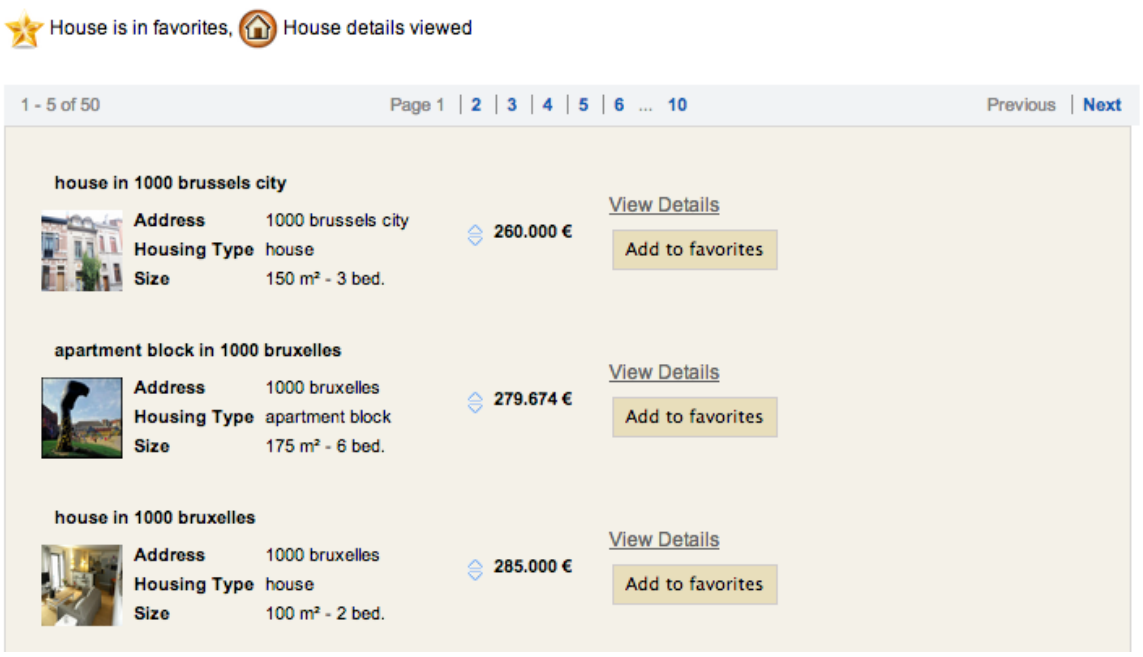


Figure 34:Viewing search results in a list



Figure 35:Viewing one's Favourite Properties

3.2.2.1.2 Implementation work for this phase

Summary:

- Connect Immoweb services to EPIC platform
- Connect CIBG services to EPIC platform
- Connect favourites database & services to EPIC platform
- Create the basic set of portlet pages for the EPIC Relocation application
- Create basic roles & permissions for the EPIC Relocation application
- Trigger calls to the User Logging webservices to track user behaviour
- Gather and publish a first batch of useful links and resources in the Living in Brussels component

The major technological challenges for this phase were introducing the CIBG and Immoweb data sources into the EPIC platform and making them available as an internal EPIC webservice to the portlets forming the Relocation Web application.

Immoweb provided a way of searching properties based on a set of criteria and a way to fetch the complete set of details for a specific property.

CIBG made available a webservice exposing a wide range of POI categories and their individual POI's.

Both partners made the effort to provide a SOAP service, the easiest way for the EPIC platform to consume a webservice.

Once those services were available, the Pilot developers created a set of reusable webservices on the EPIC platform that consumed and exposed the third party services to applications internal to the EPIC platform.

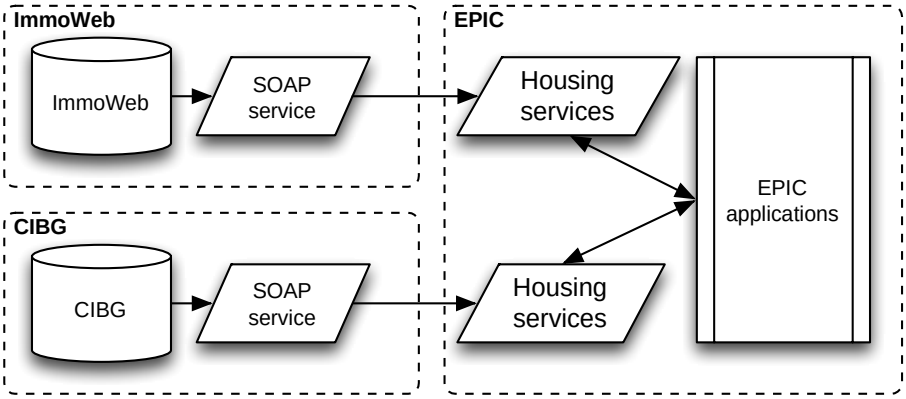


Figure 36:Simplified image of how EPIC connects to the third party services

These internal webservices were subsequently consumed and used by the different portlets comprising the Relocation Application. The EPIC platform's under layer, through a role based permissions system, takes care of making sure that only portlets and users with the proper clearance have access to the data fed through these webservices.

In order to save the user's favourites a connection was needed to be made by an external database and webservice holding user's favourites. Whereas the EPIC platform itself can store some basic user preferences, larger sets of data were agreed to be hosted external to the platform, to ensure the scalability of the EPIC idea. Applications can run on the EPIC platform, but their data best remains external to the platform.

Similar to connecting with the ImmoWeb and CIBG services, a connection was made with an external database exposed via a SOAP service.

Lastly each portlet was provided with calls to the user logging framework webservice, which was made available to all EPIC pilots. This webservice allows for key events by the user to be logged in a database.

3.2.2.2 Closed Group - Cycle 2

Only a short timespan separated Cycle 1 from Cycle 2, which enabled the development team to add a few extra features and get rid of a number of bugs that were brought to light thanks to the user testing (cf., D7.3 for the outcomes).

3.2.2.2.1 Key user feedback for this phase

- A number of bugs were reported
- More than one community (zip code) should be selectable when searching houses

3.2.2.2.2 Functionalities for this phase

- Bug fixes
- Provide a simple UI for selecting multiple zip codes or communities when searching for properties
- Display a first set of resources in the 'Living in Brussels' component

3.2.2.2.3 Implementation work for this phase

Summary:

- A JavaScript UI element was implemented in order to facilitate the selection of multiple communities or zip codes. This list of zip codes is provided as part of the search portlet and can be easily updated or changed when moving the application to a new city.
- A number of links to interesting resources was added to a new portlet page 'Living in Brussels'. The links are annotated and categorized based on Expat needs as obtained through interviews with the target group and stakeholders. Adding links to such a page is a matter of adding them to the portlet in a specific format, making a move to another city a trivial matter.

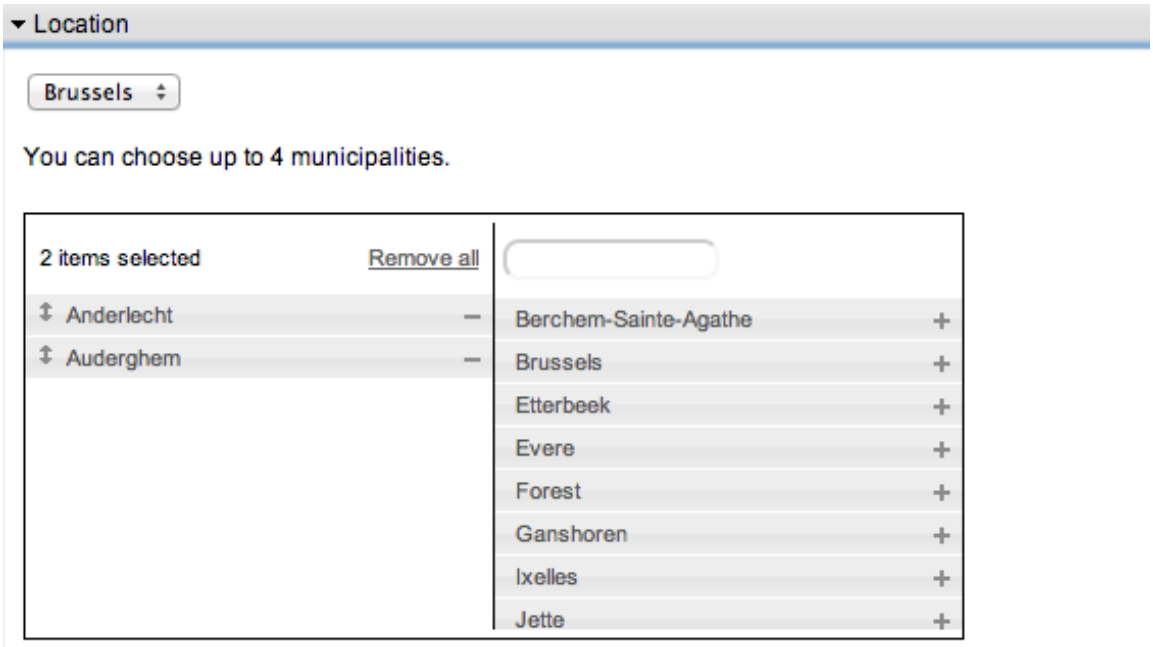


Figure 37:Easier commune selection through a javascript plugin

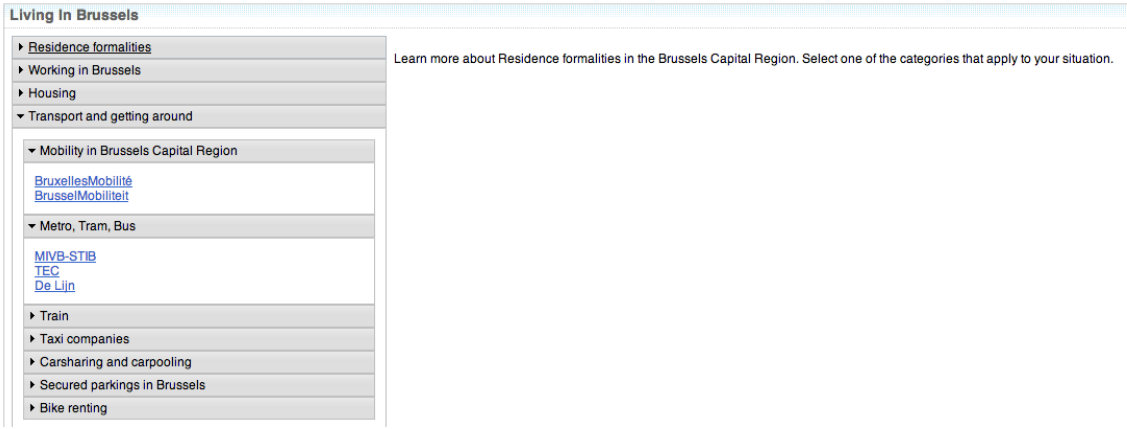


Figure 38:Categorised and annotated links to useful resources for incoming citizens

3.2.2.3 Closed Group - Mobile

A first mobile cycle during the summer of 2012 tested the first batch of functionalities planned for the mobile application. The application was delivered behind schedule due to the intricacies of exposing the existing EPIC Relocation webservices to a native application on a mobile device such as an iPhone.

Valuable lessons were learned on how to provide webservices to a native mobile application, whilst keeping user, data and service security in mind (cf., D7.3). Whereas the EPIC platform is wrapped in an authenticated layer, a webservice exposed to an external component such as a mobile application is not. Providing this layer of security outside of the platform's boundaries was a necessary exercise and very valuable as smartphone applications are plenty these days. The exercise and implementation of a first set of 'externally accessible' webservices provided lessons for the other partners used later on in the project.

In this first phase, the focus was laid on a first set of functionalities that could be used sans user authentication. A second mobile cycle would feature fully secured and authenticated webservice calls.

3.2.2.3.1 Functionalities for this phase

- Search a house
- Browse house search results
- View a house's details
- View POI around a house
- View POI around a user's location

3.2.2.3.2 Implementation work for this phase

Summary:

- Make available the housing services for mobile app consumption using a RESTful webservice
- Make available the POI services for mobile app consumption using a RESTFul webservice
- Develop a cross platform mobile application using Appcelerator Titanium and provide the functionalities listed above, consuming the RESTFul webservices

Mobile applications prefer lightweight communication with cloud services. RESTFul webservices in a JSON format are much more lightweight than a SOAP service, reducing the amount of data being transferred between both ends dramatically.

To this end, an adapter was created on the EPIC platform, translating the existing SOAP service calls into a RESTful/JSON format.

The mobile application itself was developed using Appcelerator Titanium, one of many cross platform development frameworks for mobile devices.

From a common codebase the tool allows applications to be built for iOS, Android and Blackberry devices (Windows Phone in the future). Most focus was put on an iOS application, but a working proof of concept for the Android platform was made as well.

The application was adapted in such a way that it could be rapidly adapted to implementations in other cities by simply rebranding where necessary and connecting the application to other service endpoints.

While not in the scope of the mobile test cycles, the application was nevertheless made with the idea of multi-lingual in mind. Should the occasion arise, the application's interface can be translated very easily in multiple languages, switching based on the user's language settings on the device itself.



Figure 39:First version of Mobile application

3.2.2.4 Open Group – Cycle 1

The work towards this first open cycle features a lot of work on the stability and speed of the application to make it ready for Open Group testing. Apart from that a number of existing features such as the POIs around houses are extended to show more data.

3.2.2.4.1 Key user feedback for this phase

- Bugs reported
- A number of buttons respond too slowly
- Distinguish houses from flats on the results map
- POIs around house details are perceived as very useful feature
- Visually distinguish different POI categories on the map

3.2.2.4.2 Functionalities for this phase

- Bug fixes
- Speed fix for slow buttons and portlets
- Add more links to the Living in Brussels component
- Implement a visual differentiation for houses and flats on the results map
- Increase the amount of POI categories shown next to house details

- Add different icons for each kind of POI category shown on the map

3.2.2.4.3 Implementation work for this phase

Summary

- The number of logged results is reduced to the most critical log events. Logging too many user activities (button presses etc.) causes minor delays in response which reduces the level of user-friendliness of the application
- Different icons for flats and apartments and the different POI categories are added. This is done in such a way that these are easily reusable for implementations in other cities and easy to extend, should a new city have categories that are not accounted for by icons in the current installation.

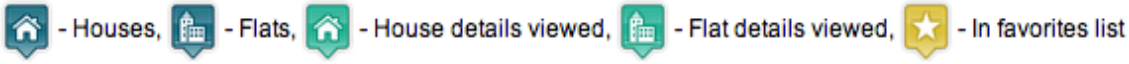


Figure 40:The results map features easy to recognize icons

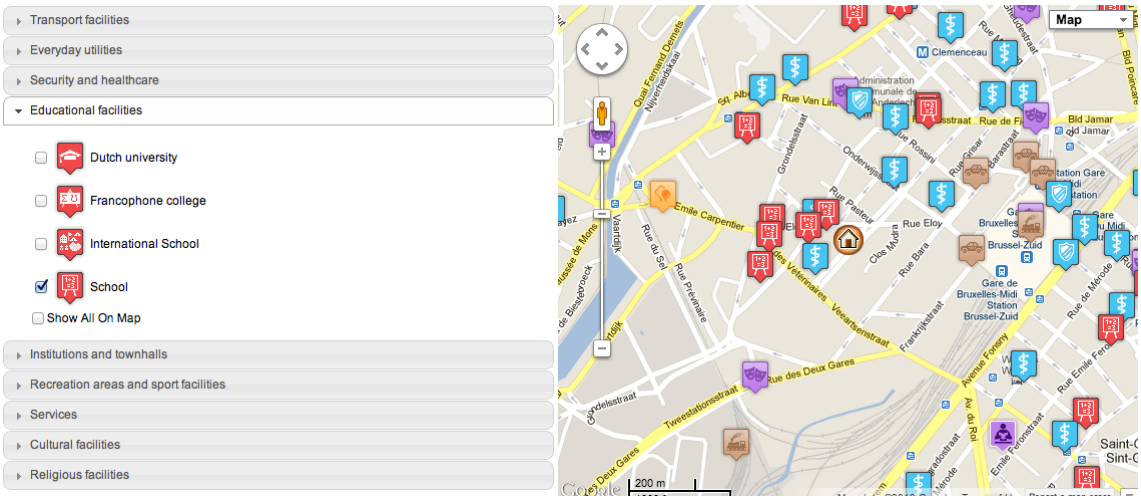


Figure 41:Icons for POI categories help users to recognize POIs on the map and link them to the list at the left

3.2.2.5 Open Group – Cycle 2

Work towards this testing cycle featured a number of bug fixes and usability updates alongside of an extension of the links in the Living in Brussels component and the addition of a FAQ (Frequently Asked Questions) portlet page.

3.2.2.5.1 Key user feedback for this phase

- Bugs reported
- Selected property in results list or map is not easily distinguishable from other properties
- It should be possible to click through from the small result map popup to the House detail page without having to pass by the list view.

3.2.2.5.2 Functionalities for this phase

- Bug fixes

- The property selected by the user should be highlighted in both the map as well as the list views
- Add a link in the popup shown when a user clicks on a search result displayed on the map, linking to the property's detail page.
- Add a FAQ page guiding test users in using the application
- Add a batch of links to the Living in Brussels portlet page

3.2.2.5.3 Implementation work for this phase

Summary

- Map results view shows a highlighted icon when a user clicks on a property. This state is stored for as long as the user's session is active. In the list view the search result is highlighted in a different colour.
- A link from within the popup window on the map now enables users to bypass the list view when checking out a house's detail page. This was more difficult than expected as the popup window resides in a JavaScript component not native to the EPIC platform.
- More links were added, annotated and categorized to the Living in Brussels component.
- A FAQ portlet was added to the Relocation Application. New pages are added very easily.

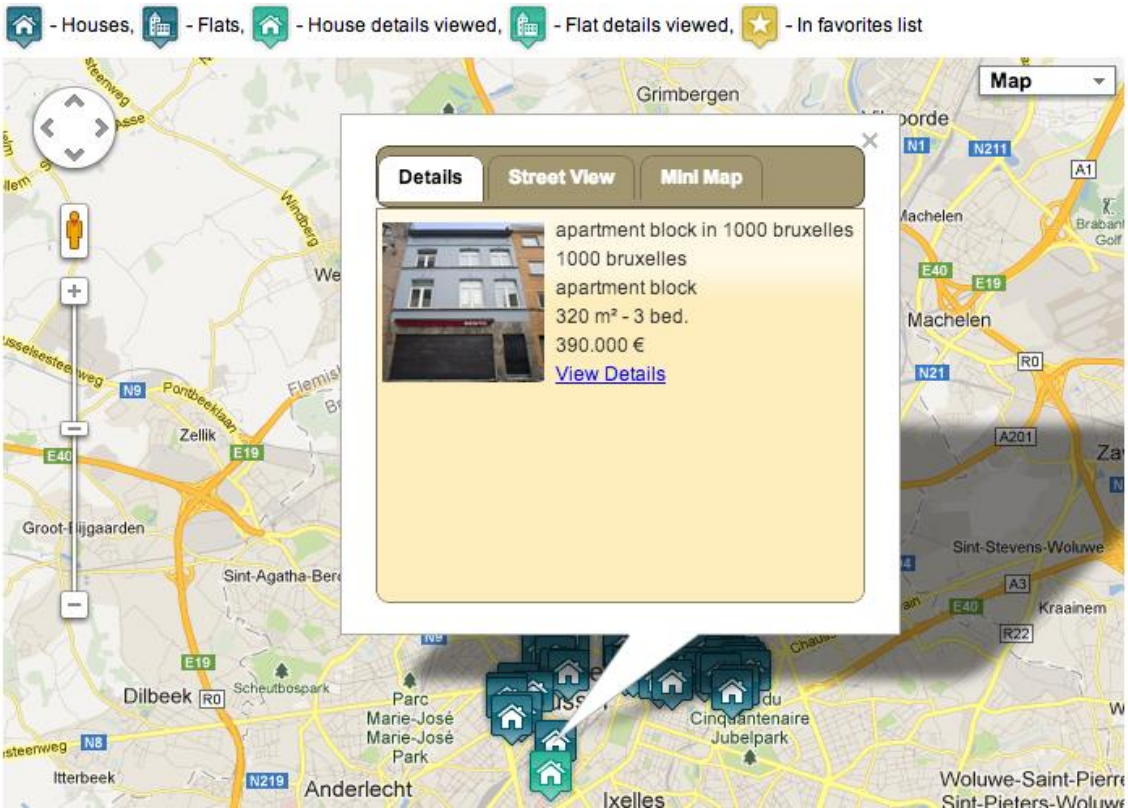


Figure 42: A 'View details' link is shown in the popup window of a highlighted property on the search results page

3.2.2.6 Open Group – Cycle 3a

The period leading up to this cycle featured a number of important and heavyweight feature additions. First and foremost was the ability to search for houses based on their proximity to a subset of POI categories. Secondly was the addition of community indicators or geo-locative, demographic data about the different communes of Brussels in a component called 'Where to Live'.

3.2.2.6.1 Functionalities for this phase

- Bug fixes
- Allow houses to be searched based on their proximity to a subset of POI categories
- Create a new component called 'Where to Live' showing a set of community indicators for a selected commune/zipcodepostal code in Brussels.

3.2.2.6.2 Implementation work for this phase

Summary:

- Added a search portlet to the Find a Place page allowing specific POI categories to be selected alongside of a maximum range.
- Integrated the feedback from the POI search portlet with a new webservice combining the Housing and POI services together.
- Created an EPIC webservice consuming CIBG demographic data
- Consuming the demographic data service in a portlet allowing a user to select a commune and see it on the map together with its community indicators.

Building the service that allows houses to be searched based on their proximity to a specific POI category (or more than one) actually gave us the chance to finally combine two external webservices into one internal service and really show the potential of the EPIC platform as a smart city tool.

All of this is done at high speed, without a noticeable delay over regular, non -POI related searches, which is impressive given the number of POIs and properties that need to be searched.

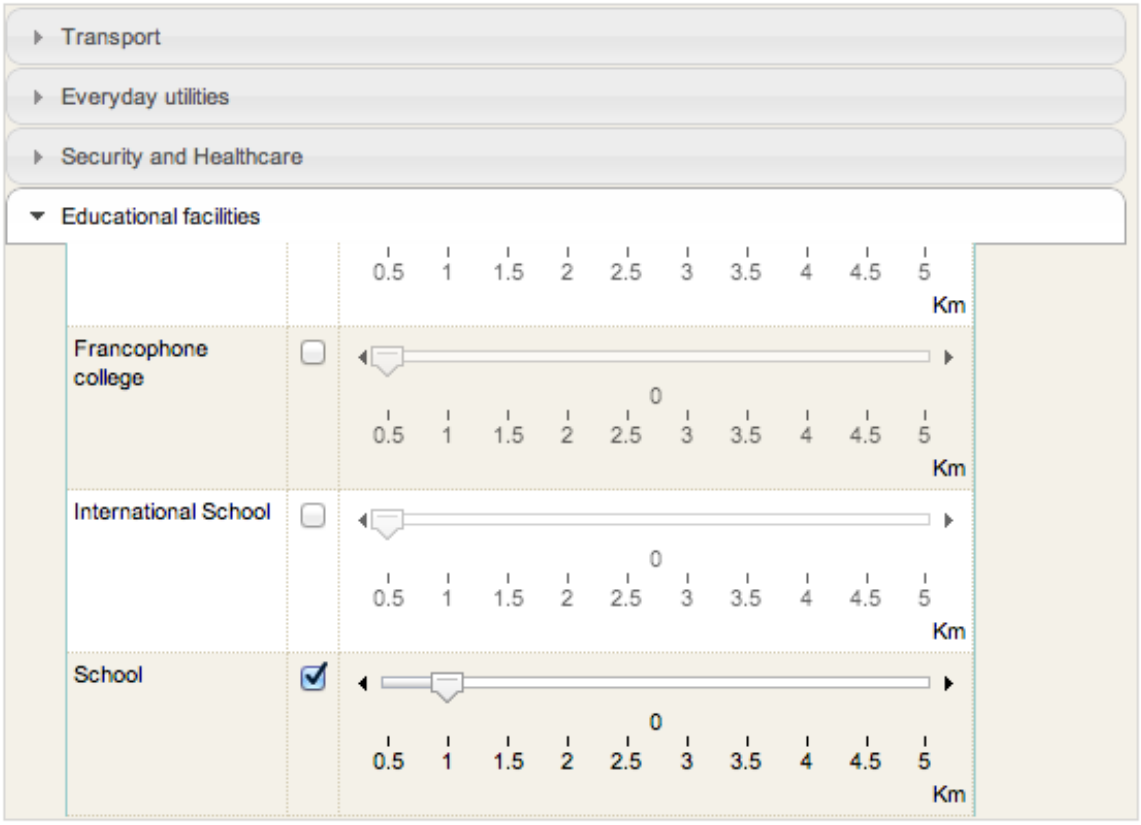


Figure 43:Searching for houses based on proximity to POI categories (max. 1 km away from schools)

Once again this service was built with reusability in mind. Upon moving the application to a new city, a minimal number of changes need to be made to bring this service up and running.

The same goes for the webservice concerned with consuming and exposing the demographic data.

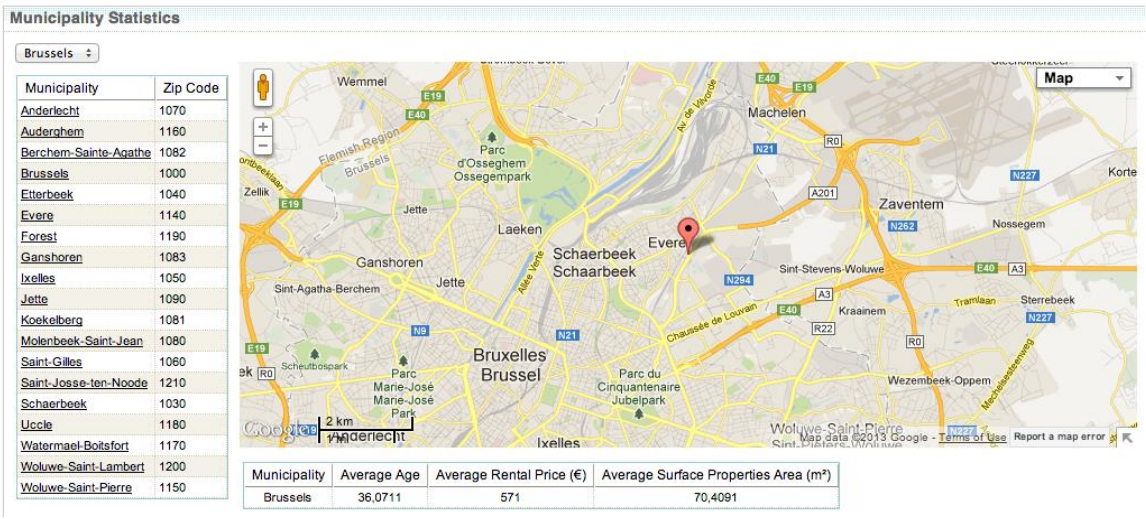


Figure 44:Showing average price in the neighbourhood amongst other data in the Where to Live component

3.2.2.7 Open Group – Cycle 3b

Towards this cycle a single major functionality was implemented: integrating a semantic engine in a proof-of-concept fashion, showing that aside from external data sources also external services could be made available for use on the EPIC platform. Alongside of that, a number of smaller fixes were implemented based on earlier user feedback (cf., D7.3).

3.2.2.7.1 Key user feedback for this phase

- Numerical values on property price slides based on 'for sale/for rent' setting are not optimal.
- When searching on proximity to POI categories and browsing to a selected house, the categories searched on, should be shown by default on the property detail page.

3.2.2.7.2 Functionalities for this phase

- Integrate semantic engine to translate the property's description on the property detail page.
- Adjust numerical sliders based on the user's selection of for sale/rent
- Store the user's selected POI categories in the search portlet and enable these categories by default on the house detail page.

3.2.2.7.3 Implementation work for this phase

Summary:

- Adjusted the search portlet to make the slider show a dynamic range of price values based on the user's selected housing type.
- Upon selecting a POI category in the search portlet, the preference is temporarily stored and used on the house detail page to shows the selected POI categories by default.
- The Frauenhofer semantic engine is integrated with the EPIC platform and can translated French text into English on demand.

The semantic engine provided by Frauenhofer can do a number of things based on text. Within the scope of the Relocation application we chose to employ its translation skills to translate the description of a property, a bit of free text filled in by the person selling the house in his or her native language. This was a much-requested feature by expats, as many descriptions were in French, which a lot of incoming expats did not understand.

Upon detecting French text in the description, the Relocation application triggers the visibility of a button enabling the text to be translated by the semantic engine. This is done on the fly by sending the text over to the semantic engine hosted externally, via an EPIC webservice connecting allowing the platform to communicate with the engine.

This proves that not only data sources, but any kind of service can be used to enrich an application. As always this EPIC service was created in such a way that is reusable and adaptable to other situations and languages.



Figure 45:The Relocation Property Detail portlet offers translation when it detects French descriptions

3.2.2.8 Open Group – Cycle 3c (4 Integrated Web and Mobile)

3.2.2.8.1 As a last series of open group tests of the Brussels Relocation Pilot, the web and mobile applications were tested in tandem as originally intended. As such the work leading up to this testing phase featured a large focus on finalising the mobile application.

3.2.2.8.2 Key user feedback for this phase (on previous version of mobile app)

- Needs an updated interface
- Needs access to personal favourites
- Needs a big speed increase

3.2.2.8.3 Functionalities for this phase

- A fully renewed interface in line with today's standards
- Connects to a renewed set of mobile webservices which are fully authenticated
- Provide access to favourites
- POI's around me now show their distance to the user for easy reference as well as Google street view integration to offer an augmented experience.
- Implement a caching mechanism so not every search or call for POI's triggers a request to the webservices. Re-use data were available and up to date.

3.2.2.8.4 Implementation work for this phase

Summary:

- A new interface was designed and implemented

- Mobile web services were rewritten to be fully authenticated
- Personal user favourites are accessible
- A caching mechanism was implemented storing search and POI data on the device and updating it whenever a connection can be made and it is necessary. This severely limits the amount of times the app needs to communicate with the server, providing a fierce speed (and battery) increase.
- POI's now show their distance to the user's current location.
- POI's now can be viewed through Google Street View as well (a gimmick, but showing that connecting to a Google service is perfectly possible)

For the tests purposed a focus was laid on testing the iOS version, but given the framework we used to build the application it could be very easily compiled as an Android application (or a Blackberry application and a even Windows Phone application in the near future).

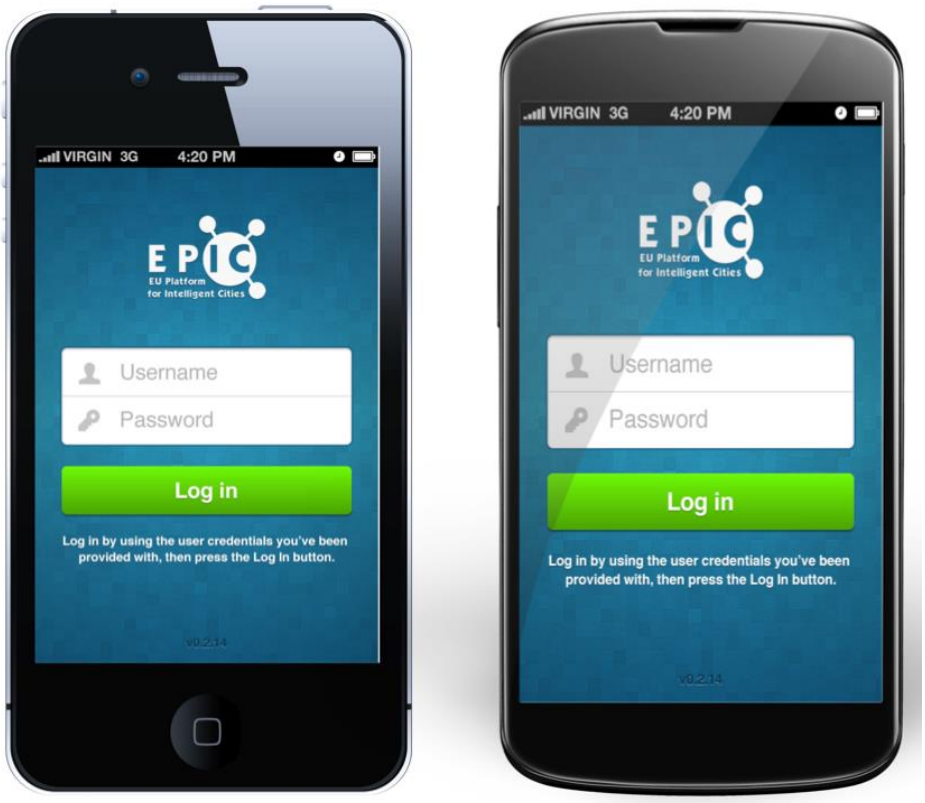
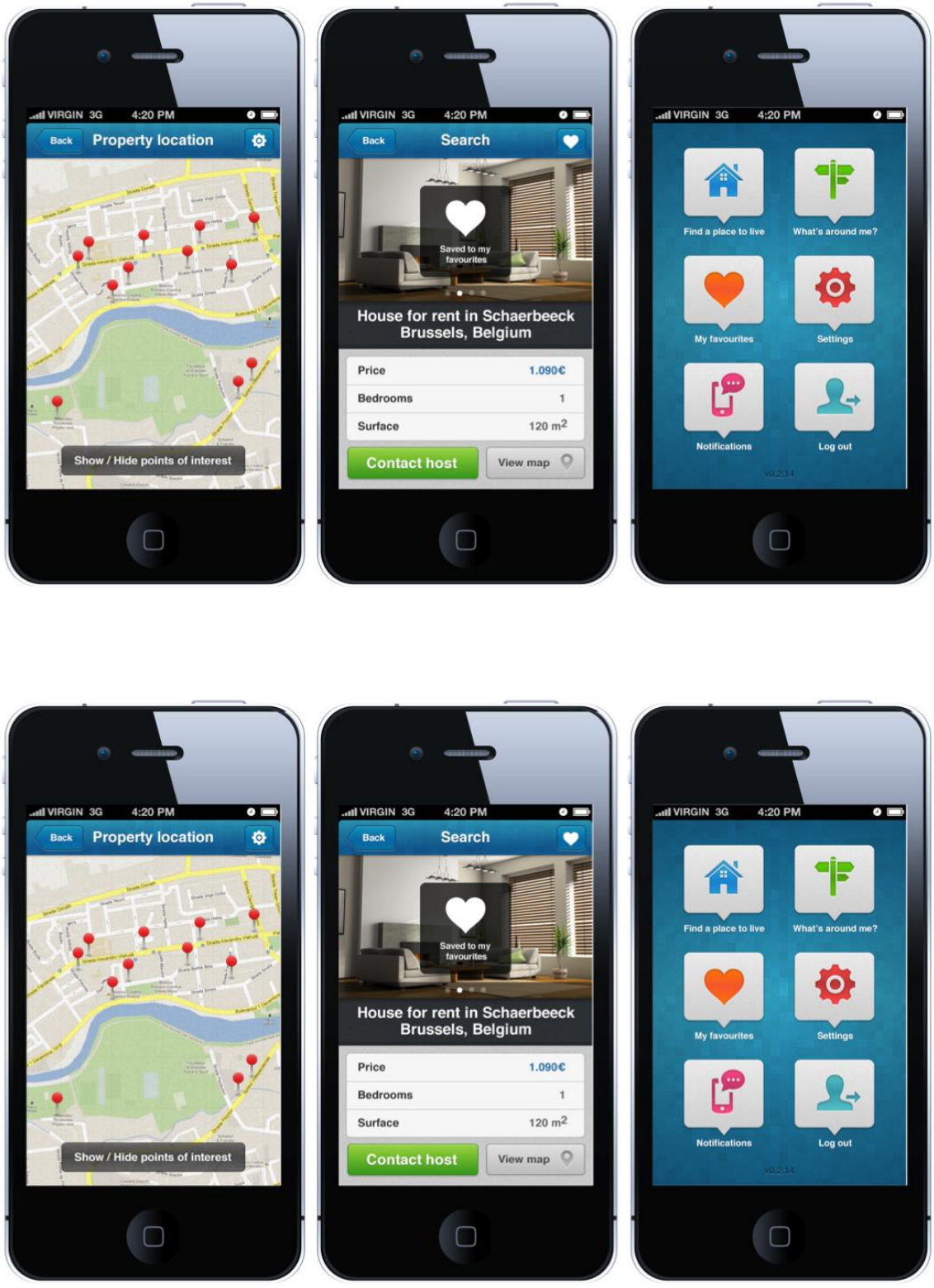


Figure 46: A restyled mobile application connecting securely to the EPIC platform



3.2.2.9 Proof of Concept - Tirgu Mures

After the Brussels Relocation test cycles, the pilot teams focused their attention to bringing their pilot applications to Tirgu Mures. It was decided that the Relocation

Application would be implemented in Tirgu Mures with a specific focus on the web component.

3.2.2.9.1 Functionalities for this phase

- Bring as many of the Relocation Pilot functionalities across to Tirgu Mures
    - Due to the absence of readily available demographics data only the 'Where to live' component didn't make it across from Brussels to TM.
- Connect Tirgu Mures (TM) Relocation application to local data sources
- Enable the TM Relocation application to be experienced in English, Romanian and Hungarian.

3.2.2.9.2 Implementation work for this phase

- By interfacing with local partners in TM, the application as a while was described, together with our requirements in terms of data.
- Both a data source for housing data as well as a source for POI data was searched and made accessible to the EPIC Relocation team.
- Prices of houses are shown in local currencies and the sliders in the search portlet are adapted to the proper amounts for both sale as well as rental prices in the area.
- Once these sources were available to us and populated, the effort of connecting the existing Relocation webservices to these new sources was minimal. In little more than a month the entire application was implemented in Tirgu Mures.
    - A number of fields that we had available in Brussels, such as a picture and a full textual description of a house, were not available in TM.
    - On the other hand the TM POI data did come with a textual description for many POI categories.
    - Both situations were handled by creating simple adaptations to the services. Even within this standardized environment there is room for adapting to specific and local needs, requirements or opportunities.
- Creating a multilingual experience required action on 3 different levels
    - At a platform level, a user would simply need to change their profile language settings to the preferred language. This would automatically change most basic interface elements, not connected to any of the pilots (the login screen for example).
    - At a Pilot (portlet) level, the interface elements would need to be adapted based on the user's settings. The portlets were adapted to read the user's preferred language settings and then load a translation file, filled with translations for any portlet level interface element (such as the button to 'search' for example).
    - At a pilot (portlet) level, the actual content coming from the third party services needed to be in the proper language as well. This was done by reading the preferred user language setting from the EPIC platform user services and passing this language on as a parameter to the third party

services providing housing and POI data in TM. It should be noted that these third party services need to be adapted to pass on the proper language version of their data of course.

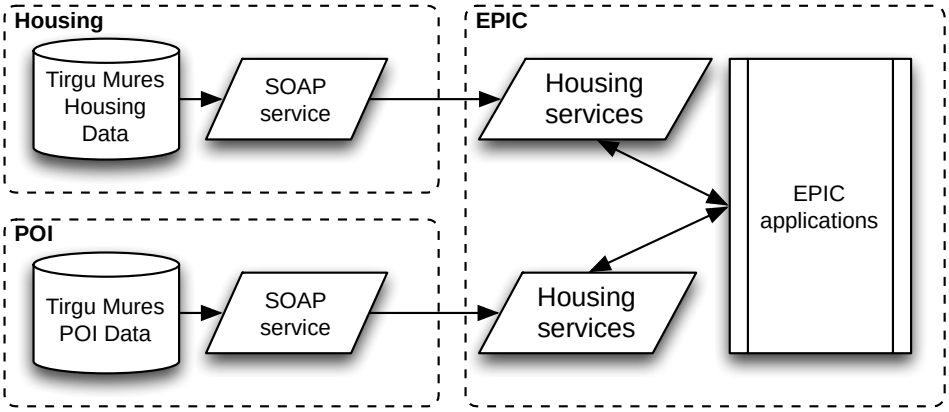


Figure 47: Adapting the EPIC services to new data sources is straightforward

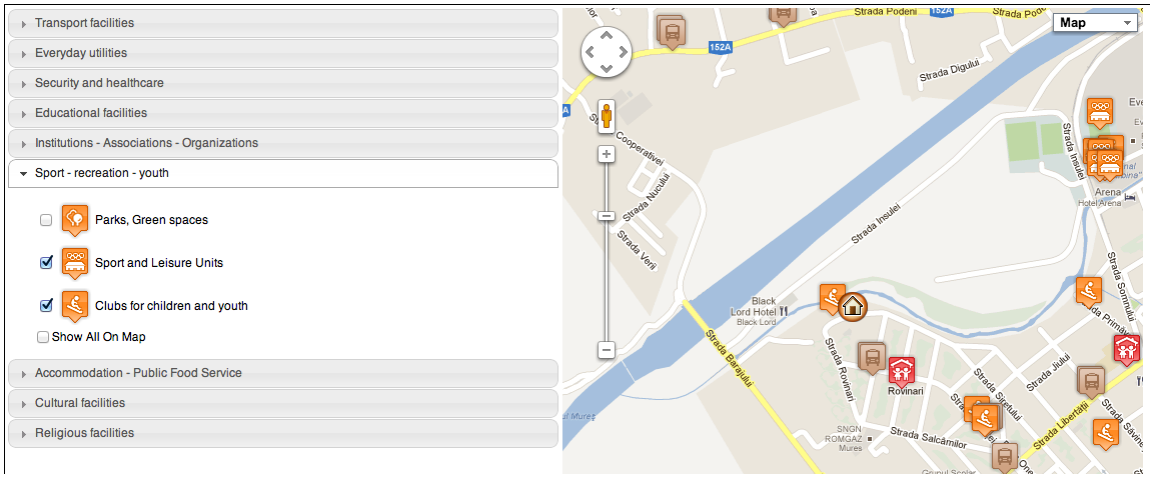


Figure 48: POI's around a house in Tirgu Mures



Figure 49:House details in Romanian

3.2.2.10 Integrated Scenario

A last exercise consisted of the interaction between the three pilot's web services with each other in a real-world scenario. For this purpose the pilot partners opted to show energy data coming from the energy meters provided for by the smart energy pilot in both Relocation as well as Urban Planning applications.

In the case of the Relocation application it was deemed most useful that houses for sale or rent that had a smart meter installed would show up with a special symbol and have their average energy usage compared to the average of all houses in the area.

3.2.2.10.1 Functionalities for this phase

- Extend the housing search to return which houses have an energy meter
- For those houses, show the average energy consumption on the detail page as compared to the average of all other houses in the area. (for the save of the exercise one house with a meter was added to the housing database).

3.2.2.10.2 Implementation work for this phase

Summary:

- A house known to have a working smart energy meter was added to the housing database
- When this house appears in the search results it is shown with a specific icon
- When the details of this house are viewed, the average energy consumption as well as the average consumption of all houses in the area is shown as part of the property's details.



Figure 50: Energy consumption is shown as part of the house's details

3.3 Adaptation of Smart Environment Pilot

The entire domestic energy pilot was designed and built in 12 months following the withdrawal of Hildebrand at M21. This required intense working by the BCU technical team supported by IBM to design and implement a pilot ground-up.

Because domestic energy ad public buildings energy were built ground-up for EPIC, rather than being existing applications that were ported in to the EPIC platform, there was no technical adaptation of existing solutions required. Smart Environment was built from the outset on the EPIC platform using web-services and portlets as per the EPIC platform architecture.

3.3.1 Proof of Concept Implementation in Tirgu-Mures

Implementing the Smart Environment proof of concept in Tirgu Mures was somewhat easier for than for the other pilots due to the lack of location-specific information such as maps, points of interest and 3D city models. However, one complexity not found in the other pilots was the establishing of energy data flows from domestic premises and commercial buildings in Tirgu-Mures, with a requirement to install energy monitoring equipment in Tirgu Mures.

Because both elements of the Smart Environment pilot had been developed entirely within the EPIC project rather than being pre-existing applications that had in part or in whole been migrated to the EPIC platform, they had been implemented ground-up by the technical using web-services and portlets.

The generic monitoring framework (GMF) that received all data feeds was developed off-platform and all data was exposed using web-services running on the GMF server. These were in turn exposed to the EPIC platform via web-services running on the EPIC platform, replicating the relationship between a third-party web-service and exposure of this via the EPIC platform. It was therefore not necessary to make any modifications to the GMF to accommodate data flows from T-M, apart from creating the valid sensor identifiers that would be assigned to the T-M data streams.

For domestic users in T-M the only difference was around language options on the portlet, but the same hardware as used in Manchester was supplied to T-M for two domestic installations.

For public buildings however things were rather different, as no smart-meter feeds were available from public building in T-M. To overcome this problem, a hybrid solution was created by the technical team, which combined elements of the domestic monitoring hardware and MQTT data transport used in Manchester, with a modified web-service to visualise the T-M data via the Manchester smart-buildings dashboard.

A 3-phase version of the domestic energy monitors was used to measure electricity use in several Kindergartens in T-M, and these data-streams were identified as commercial not domestic, although they were stored in the GMF in the same way as all other data flows. However, whilst the data was delivered using MQTT as per the domestic data, it could not be aggregated with or visualised by the domestic energy dashboard, as the

public buildings from T-M needed to be comparable with the Manchester building data which was visualised by the public building dashboard.

The BCU technical team therefore created a smart web-service, that queried the 6-second power measurement data from the public buildings in T-M and returned this as energy consumed in 30-minute periods, the same format as that supplied by the Manchester building smart meters. In this way the domestic energy hardware provided the public building data for T-M, which could still be visualised as if it had been supplied by a smart-meter, due to the data-processing functions of the smart web-service.

This demonstrated the power of using web-services to expose and aggregate disparate data feeds. From the perspective of the application using the web-services, public building data was exposed in the same format irrespective of whether it emanated from Manchester buildings BMS or the modified domestic monitoring hardware installed in public buildings in T-M. This insulated the portlet consuming the data from the specifics of the data, and enabled web-services to be consumed by other pilots without modification.

3.3.2 Integrated Scenario

The integrated scenario was the final phase of testing. Pilots consuming EPIC web-services that were created within other pilots demonstrated the reusability of web-services. This demonstrated how the EPIC platform could act also as a data provider to third-party developers through exposing data feeds as web-services so that developers could create their own applications to consume and display this data, either a portlets, using standard HTML or in mobile apps.

Smart Environment did not consume any web-services from relocation or Urban Planning, but was instead a provider of domestic energy data to Relocation and Public building data to Urban Planning in the T-M proof of concept.

The web-service created and used by the BCU technical team in the domestic and public buildings dashboard were consumed by the other pilots without any modifications, to provide energy data for the two houses in T-M that appeared in the relocation pilot and the public buildings in T-M that were providing energy data.

The successful re-use of the smart environment web-services demonstrated the practicality and extensibility of the EPIC architecture and the potential for re-use of third party data through the implementation and licensing of EPIC web-services which consumed the third party data provider web-services and presented these to EPIC platform users a components.

3.3.3 Conclusions

The use of MQTT, an IoT protocol for distributed sensors proved extremely effective, and delivered reliably the energy message sent by each domestic sensor once every six seconds, corresponding to 14,400 messages per day per home

The architecture of the GMF which sits behind the smart environment pilot has worked 100% reliably and now contains almost 30 million energy readings, mainly domestic data

The ability to visualise instantaneous power-usage and cumulative energy consumption helps households to understand their consumption, and particularly the quiescent consumption of the house when unoccupied and the effect of high-load appliances such as electric showers, kettles, electric ovens, water heaters and dishwashers. It should be emphasised that the aim of the domestic energy pilot was to help users understand energy use, not to offer a billing function.

The Public Buildings dashboard was a new deliverable not contained in the original DoW, and created by the BCU Team to broaden the applicability of smart environment to cities and businesses. The re-proposing of data-feeds available from existing fiscal smart-meters meant that no additional equipment was installed in the monitored buildings once access to data feeds has been arranged. Most BMS have a daily reporting function and this was used to create a daily report that was emailed to BCU with a data attachment. This was automatically processed, extracted and inserted into the GMF.

The re-purposing of domestic hardware to perform 3-phase monitoring for commercial premises in T-M but then processing via a smart web-service the 6-second power data to create the 30-minute energy data typical of fiscal smart-meters demonstrated to power of web-services to present data in a consistent form irrespective of the original data source.

One on-going issue was the stability of domestic broadband connections that could lead to periods of connectivity loss and consequent data loss. In extreme cases this needs rebooting of the domestic router to remedy, but the users need to be alerted to the problem. Whilst the latest versions of the custom firmware created for the TP-Links handles most connection loss transparently and automatically re-established a connection to the MQTT server, it cannot reboot the user's router if this is required.

4 Pilot Adaptation Rules and Criteria

4.1 Urban Planning

4.1.1 Strength

NAVIDIS R&D has developed a unique "3D immersible" visualization concept to discover a territory and its projects, to develop strengths in a form at once intuitive, spectacular, fun and informative.
This approach proposes a specific adaptation in terms of design and ergonomics to best meets the needs of the City, the wealth of its territory at different levels of information.

- Very differentiating approach compared to Google map
- Identity of the city respected
- 3D Model with fun and easy navigation
- Many features are already available
- Ability to connect to multiple sources of information (GIS data, Open Data, Big data ...)
- Flexibility to implement new services
- Middle Ware based on the NAVIDIS evolutionary framework
- Capability to set a prototype quickly for validation
- Players extendable to all available devices like touch screen, tablet and smartphone
- Fluid and intuitive use; Interactive show and spectacular solution for relevant information
- Treatment with both realistic and symbolic information for better readability;
- Behavioural treatment of media to facilitate access to information;
- Artistic upscale treatment and unique interface strengthening the identity and image of the territory;
- Unique know-how in "interactive communication"
- Expertise in 3D design, geographic information systems, multimedia and gaming.

4.1.2 Weakness

Some major weaknesses have been identified, some due to EPIC architecture and other due to features missing in Urban Plan solution that were expected by few users:

- Customer Management -> impossibility for a self-registration, so citizen can't use it if the city administration can't rely the demand and communicate a login and a password
- Web Services access -> security Issues and guidelines make difficult integration of new services or applications provided by a partner
- Search -> Search web services are missing (word, template, etc…)
- Administration tool -> a bit too basic and required additional features like management of mapping, shading, video, document, template, web link, 360°, etc…
- Administration tool -> missing capability to add & remove an urban project to check it in the 3D
- External reference -> are missing capability to use Openstreet map and Wikipedia web services (and why not Google and Bing too)

- Design issues -> when important number of POIs, the 3D Map is imprecise and POIs covered themselves making some not visible or non-understandable .

4.1.3 Recommendations

A free solution can be proposed to the City based on a standard 3D model build with available data and displaying geolocalized POI dispatched on 3 layers and coming from Open Street Map & Wikipedia.

Here is a quick view of the process for setting the Smart City solution with any City:

- What are the City requirements
- What are the data available :
    - Data gathering from the city (GIS, Cadaster, Urban model library)
    - Data gathering from other places (Open Data and any other external Sources)
- Propose and validate the 3D Model
- Define Interfaces and Interactions specifications
- Develop additional features if required
- Get it integrated into the NAVIDIS Framework
- Test and validation with the City
- Publishing for the web and for any other devices

That means specific resources are mobilized within the City like a **Program Manager** for clearly setting the needs and requirements of the City, the **Project Manager** for following organization, plan and resources commitments, the **GIS Manager** providing information, geographic data sources and web services details, the **Content Manager** providing additional information for POI like descriptions, medias, web sites and web service details, the **City Administration Representative** and **Test Manager** able to validate the solution and ensure that it works as expected.

On NAVIDIS side, the team will be composed by a **Project Manager** in charge of the customer relationship to ensure that needs, requests, specifications and solution are in line with the expectation of the customer, **Geometrician- Cartographer** for managing GIS and POI data and generate the 3D model of the city, **Artistic Director** and designer for setting ergonomics, interface, interactivity specifications, **3D Graphic engineer** for developing 3D Model and 3D objects, **3D Unity engineer and Data Base, Internet and Mobile Engineers** for developing the solution. When all data are available or

accessible, one month max is required to make complete the application available for testing with users. And the steps are:

- **Modelling:** 3D Cartographic modelling begins with data collection to ensure all required information are available to reach the goal.
- **Development features:** In this phase the principles of ergonomics, graphics, interfaces and interactivity across all contents are declined. This layout defines the final outcome of the application. It is also during this phase that the administrative tool is adapted to meet the specific needs of the Client. Then these elements are integrated into a functional interactive model, allowing choice optimization and any necessary adjustments.
- **Integration and advanced features**: This phase refers to the integration of all objects (2D & 3D objects) and multimedia data managing through the Media Centre. This integration allows putting into action the principles of interactivity and testing the "playability" of the application (displaying time, cognitive ergonomics, weight and balance of graphic pages, etc...). This development and integration phase is done on the Navidis development platform, and under the guidance of the Technical Director.
- **Tests and modifications:** Once the integration is completed, a prototype is presented to the City client for the test phase under EPIC. Assistance and support are provided to the customer to test the application. Successive tests are performed to optimize the application and make any required changes leading to the complete recipe of the application.

4.2 Relocation Service

4.2.1 Strengths

- A unique combination of Housing data, POI and Regional data elevating the existing case of finding a place to live to a new level.
- A complementary combination of a web and mobile application, each focusing on the uses cases they work best in.
- Usable during all phases of the moving process, from discovering the city and finding a place to live to getting directed to the proper services once the step is taken.
- Built on a firm platform that is multilingual-ready
- Easily integrated with a wide range of data sources and useful services
- The more data and services available in the Smart City brought together by the EPIC platform, the richer the experience.
- Integration with city administration services is possible.
- Integration with other applications available within the smart city's cloud is possible.

- Is implemented relatively fast in a new environment

4.2.2 Weaknesses

- Specific peculiarities in local data sources ideally requires extra attention and modification
- Unable to be used by non-registered users, although the mobile application could be configured to have a public and non-public component, so that one could lead users to registering or asking for registration.
- POI data is limited in description at this point.
- Aggregating data about POI's from other sources is unexplored at this point.
- Social interaction and social feedback on the application is unexplored
- Fully dependent on external parties to provide data, so the Relocation application is dependent on these parties for both the format, quality as well as the stability of the data over time.

4.2.3 Implementation process

This section describes the implementation process in a new city from a **practical** perspective.

In order to implement the Relocation Application in its current form in a new setting the following steps need to be taken:

4.2.3.1.1 Gathering local requirements

Every location is different and has different requirements or peculiarities to take into account. In a first phase the application is presented to the stakeholders involved and each aspect of the application is discussed in detail.

4.2.3.1.2 Locating data sources and responsible parties

As the application is fully dependent on external data sources, finding partner organisations in the new city is of primary importance.

The Relocation application needs a:

- **Housing data provider** – which provides webservices to search properties as well as offer detailed information about them
- **POI data provider –** which provides webservices exposing a wide range of POI categories and their POIs to the platform
- **Regional demographic data provider –** Providing useful statistics about the city and its different areas to the platform.

4.2.3.1.3 Connecting the data sources

Once made available, effort needs to be made to consume these data sources and make these available to the portlets.

4.2.3.1.4 Adapting the portlets to the data sources and local requirements

Based on the specific characteristics of the local data sources and the local requirements gathered in the first phase of the project, the portlets are adapted to the local context. This also includes styling the portlets to the required house style.

4.2.3.1.5 Accounting for multilingualism

Based on the local requirements the portlets are adapted to the local languages and locale preferences (such as date notation and currencies).

4.2.3.1.6 Providing local content

Some pages contain statistical content that needs to be provided for in collaboration by local partners. For instance, the 'Living in X' component needs a rich collection of annotated and categorized resources useful for people moving to the city. This is best gathered by local sources.

4.2.3.1.7 Testing and evaluation

Once these steps are taken the application is functionally ready to be tested and evaluated by local stakeholders and adjusted where needed.

4.3 Energy Monitoring

Adaptation of the Smart Environment pilot to work in Tirgu-Mures was much simpler than for the other two pilots because there was no reliance of geographic information; points of interest; maps; 3D city models or other location specific data. Once energy data feeds had been established these could be fed to the Manchester dashboard.

The delays encountered in designing and building an entirely new domestic energy solution meant that the Manchester and Tirgu-Mures solutions were delivered simultaneously through a single dashboard to allow simultaneous testing.

The hardware used for domestic energy monitoring with open-group users in Manchester was used for domestic installations in Tirgu-Mures with no modification. The same TP-Link with the same firmware published data to the WebSphereMQ MQTT broker irrespective of geographical location, once internet connectivity was established.

The sensorID, namely the MAC address of the TP-Link identified the sensor feed so that Tirgu-Mures data could if required be separated from Manchester, but this was not done as only two domestic installations were implemented in Tirgu-Mures.

In essence there was no change required either to the energy sensors; the TP-Link firmware or the EPIC platform to establish domestic energy data feeds from Tirgu-Mures and to view these on the domestic energy dashboards once the senor feeds and usernames has been authorised.

The fact that the BCU team was able to post to Tirgu-Mures the necessary equipment and that this was installed by the Tirgu-Mures staff without any technical interventions from BCU indicates that the hardware solution is reusable. Once the TP-Link made contact with the MQTT broker, data started to flow automatically from the domestic

installation and could be visualised on the persona energy dashboard within 5 minutes of first receipt.

The Domestic Admin tab on the admin view of the portlet allowed the status of domestic energy feeds to be checked by user managers in Manchester and Tirgu-Mures. This showed which sensors were online and the timestamp of the last data update received. An example screen-grab is shown in Figure 12 below:

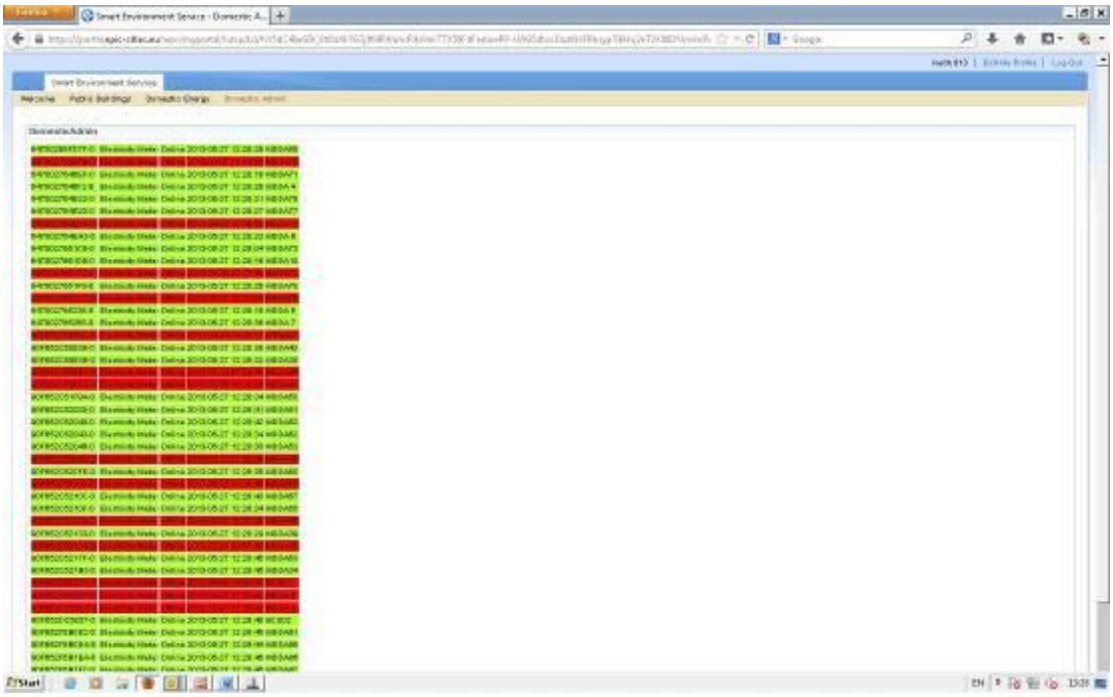


Figure 51: Domestic Status Portlet Admin View

4.3.1 Public Buildings in Tirgu-Mures

The public buildings solution in Manchester relied on access to the half-hourly smart-meter data exported by the building management systems or the fiscal smart-meters. In Tirgu-Mures however, none of the buildings of interests had smart-meters or a building management system, yet the city administration was keen to demonstrated how energy use between different Kindergartens could be compared using the public buildings dashboard.

It was therefore necessary to create a hybrid solution, employing the domestic energy hardware and MQTT to provide instantaneous power data to the GMF, but then to process this through a modified web-service, to provide “pseudo” half-hourly energy use data to match that received from the Manchester buildings. The Tirgu Mures public buildings used the domestic data acquisition part of the Manchester pilot but with the two additional inductive clamps per installation for monitoring of 3-phase electricity and used the same public buildings dashboard as used for Manchester buildings to visualise the data, once it had been converted into the same form as the Manchester smart-meter data.

This approach further demonstrated the logic of using web-services to process data. The public buildings dashboard was able to consume 6-second 3-phase power data from the T-M buildings as if it were the 30-minute consumed energy data from Manchester buildings because the web-service handled the complexity of data processing, insulating the portlet which consumed the data from differences in the underlying data. Figure 13 shows the weekly energy use of Building G in Tirgu-Mures.



Figure 52: Energy Use of Building G, a Secondary School in Tirgu Mures

In summary therefore, the implementation of domestic energy monitoring in Tirgu-Mures required no change to the monitoring hardware, MQTT broker or domestic energy dashboards, and was "plug and play" as soon as data feeds were established.

The situation for public buildings was more complex as no smart-meter feeds or BMS exports were available for the schools in Tirgu-Mures. Therefore a hybrid solution, using the monitoring hardware and MQTT data-transport of the domestic solution, combined with the adaptation of the public buildings web-service, allowed the public buildings dashboard to be re-used without change, simply by ensuring that the underlying web-service handled the complexity of different data types.

5 Conclusions

The innovation experienced during the project, developing the three pilot applications, has been very instructive. There are three applications providing a real value to the EPIC platform, being applications for a Smart City. All cities that will join the EPIC platform can be served. Throughout the development we have enriched our applications with our own experience and also with feedback from the different categories of users. We have also shown that we were able to integrate different services from other pilots; Within the Urban Plan application, we were able to integrate the service provided by "energy" and display in real time the electricity consumption of a building. Then we have also incorporated the real estate part of the application "relocation" even if we have not been able to implement the proposed “Semantic” search engine.

We now have a method to make these applications available to any city wishing to use EPIC. A method which comprises the rules and criteria as well as managerial structure of the project, the resources required and the time required for successful deployment.

We are technically ready to move to the commercial phase of EPIC if an “adhoc” structure is implemented.

6 Annexes

UNITY: a game development ecosystem

- http://en.wikipedia.org/wiki/Unity_(game_engine)
- http://unity3d.com/

CityGML: a standard to modelise and exchange urban data

- http://www.citygmlwiki.org/index.php/Main_Page
- http://georezo.net/blog/geointerop/2011/09/08/citygml-un-standard-federateur-de-modelisation-et-d'echange-de-donnees-urbaines-3d/

LOD: Level of detail

- http://en.wikipedia.org/wiki/Level_of_detail
- http://www.ifp.uni-stuttgart.de/publications/phowo11/060Becker.pdf
- http://www.tomtom.com/lib/doc/licensing/I.ACM.EN.pdf

Web Service:

- http://en.wikipedia.org/wiki/Web_service
- http://searchsoa.techtarget.com/definition/Web-services
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SOAP vs REST:

- http://en.wikipedia.org/wiki/Service-oriented_architecture
- http://www.infoq.com/articles/rest-soap-when-to-use-each
- http://benkirane.blog.parisjob.com/index.php/post/2012/05/Architecture-logicielle-%3A-SOAP-vs.-REST-Web-services

OpenStreatMap:

- http://en.wikipedia.org/wiki/Service-oriented_architecture
- http://www.ncolomer.net/2011/06/use-openstreetmap-web-api/
- http://www.programmableweb.com/api/openstreetmap