D3.3 WATERNOMICS Apps

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Executive Summary

This deliverable aims to describe the different applications developed under the scope of Waternomics project. Since the nature of the deliverable is Other, this report aims to accompany the actual deliverable which the set of applications that are included in the Waternomics Applications Platform (http://apps.waternomics.eu).

Applications are the actual points of interaction of users with the data kept in the Waternomics Information Platform. Therefore, the users' opinion and needs are crucial in their development. The first year of the project included a series of user tests that revealed the complexity of the problem ahead. In order to meet the different needs of a wide and diverge set of users in the different pilot environments there was no one-size fits all solution. We should follow an approach that would room for personalization through the development of different applications for different users. On the other hand common need patterns identified suggested that although applications must be different for individual user groups there is still a need for common components able to be combined and produce such applications in an easy way. Those components are described in D3.2.

This deliverable, focuses on the applications developed for the different pilots. In total the deliverable presents 20 applications developed targeting 19 different user groups in the 4 pilot sites. In some cases, applications are described in families where more than one actual application instances are deployed to tailor them to individual user groups and their needs. Dashboard applications is such an example where users create as many dashboard applications as they like to fit their needs. This means that the actual individual application instances deployed is much higher than 20 and quite dynamic as a number since the same application is deployed multiple times for different user groups or even for the same user based on his/her individual needs.

In such a complex context as the 4 different pilot sites and the 19 different user groups there were 5 specific applications that will be used in all pilots. These applications are the cross pilot applications and target specific user groups in each pilot site. For the pilot in Linate airport there are 4 additional applications developed with 2 of them (managers and technicians dashboards) being actually families of applications that aim at delivering personalized information to their users. For the pilot in Thermi there are another 4 additional applications developed with 2 of them (family dashboards and leaderboards) being families of applications leading to even more individual instances deployed. Finally, the two pilot sites in Galway have 6 applications being developed for them where 1 (manager's dashboard) is actually a family of applications and 2 more (goal oriented accessing water and physical consumption feedback) demonstrate innovative approaches to communicating messages to users while using water in everyday activities.

The applications presented in this deliverable answer in all needs and requirements identified in earlier deliverables while at the same time create an ecosystem of applications for personalized information delivery that also encourage social interaction and collaboration to raise awareness for water consumption.

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1 Introduction

The goal of Waternomics is to explore, develop and introduce ICT technologies that can help households, businesses and municipalities with reducing their consumption and losses of water. A key component of the Waternomics information platform aims at collecting water consumption and contextual information from different sources to be used for effective data analytics to drive decision making: e.g., planning, adjustments and predictions and to raise user awareness of water consumption.

A key outcome of the work carried out in Work Package 3 consists of designing a Linked Water Dataspace. A dataspace is an emerging information management approach used to tackle heterogeneous data sources and that supports requirements, such as standardization, enrichment, and linking of data in an incremental manner. The first version of the Linked Water Dataspace has been reported in D3.1.1 and a final version will be in D3.1.2. D3.2 followed up on D3.1.1 and presented services and component libraries that feed information to a set of components that can be used to develop customized and personalized applications in a modular way. It is these applications, their key characteristics and functionality are presented in this deliverable along with some initial introduction to their business value proposition.

1.1 Work Package 3 Objectives

The objective of Work Package 3 (WP3) is to develop the project software and user environment that will deliver water information services to various targeted stakeholders. It allows linking water metering sensors and data management systems. More specifically, the objectives of WP3 are as follows:

- To develop a linked dataspace able to capture and store data from various sources
- To develop a set of services based on the web as a platform allowing applications to interact and use the data stored in the linked dataspace
- To provide a set of applications consisting of various customisable and personalised components
- To deploy and customize the developed applications in appropriate sites for validation and evaluation

WP3 will receive as input the high-level system architecture, usage and exploitation cases, and KPIs for reporting from WP1. WP3 will provide as output the water information services platform for the pilots and future exploitation as a primary project outcome/result. In particular, WP3 will develop and provide user friendly content, applications, and platforms that enable all stakeholders (utilities, commercial users and domestic users) to take decisions that result in reduced water consumption and losses, and increase overall awareness of water consumption issues.

1.2 Purpose and Target Group of the Deliverable

This deliverable aims to present the wide range of applications developed by Waternomics consortium partners for the four different pilot sites. The deliverable describes the underlying infrastructure of the Waternomics Applications Platform (WApP) that aims to provide a single point of concentration and presentation of all applications for all users. It continues by describing the functionality of the different applications developed for each pilot site and finishes the presentation with five common cross pilot applications. The deliverable is targeted to pilot users and members of the consortium as a point of reference for the wide range of applications and how they link with requirements identified early in the project, pilot plans and their

objectives and specific target user groups. Moreover, it also targets potential users outside the consortium in order to understand the dynamics of such a platform, have a taste of the potentials it offers in terms of functionalities and applications, and relate with the business value proposition it can offer to them.

1.3 Relations to other Activities in the Project

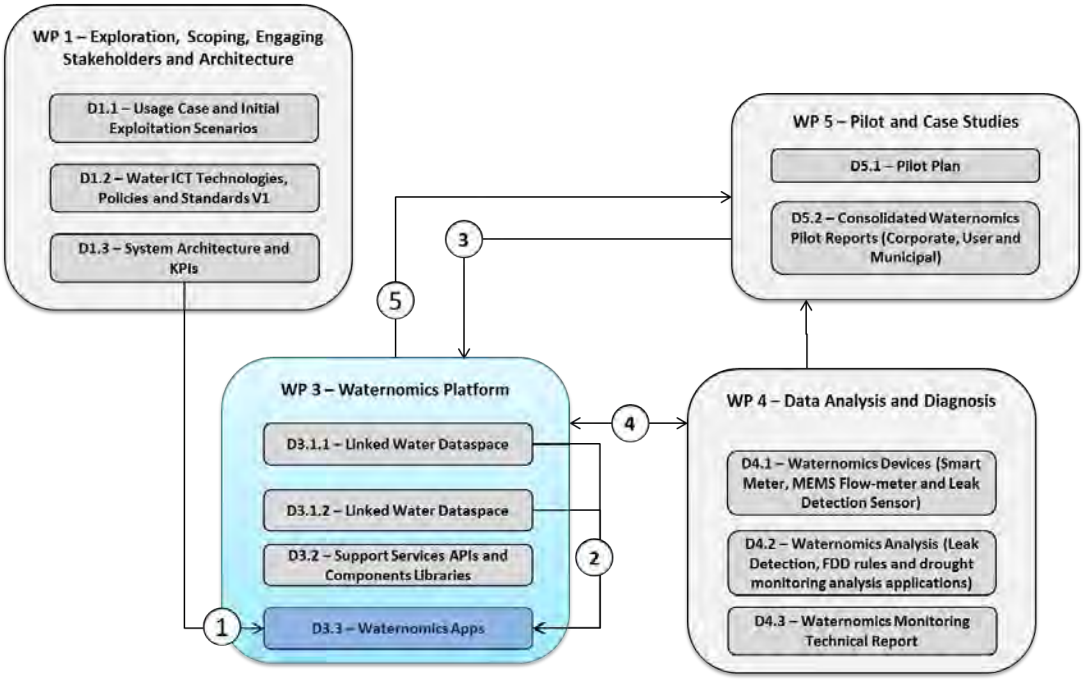


Figure 1: Relations to other work packages and deliverables in the project

Figure 1 illustrates the relations of this deliverable to other activities in the Waternomics project. These relations are represented as links numbered from 1 to 5 and are described as follows:

Link 1: The development of applications followed the set of requirements identified in Section 2 of the Deliverable D 1.3.

Link 2: The development of custom made user applications and the configuration tool makes use of the components described in Section 5 of D3.2. Applications developed are also using data directly from services presented in Sections 3 and 4 of D3.2. It also uses data from the Linked Water Dataspace described in D3.1.1.

Link 3: Applications developed are aligned with pilot plans developed and presented in D5.1

Link 4: Applications for leak and fault detection and for drought monitoring will be described in detail in D4.2

Link 5: Results from usage of information in relation to pilot objectives are presented in D5.2

1.4 Document Outline

The remainder of this document is organised as follows:

- Section 2 introduces the concept of the Waternomics Applications Platform (WApP) as the key concept around which different applications for different pilots are developed. It

describes the rationale of following a market place like approach and the benefits of this approach for the Waternomics ecosystem of applications and follows to present some key features of the platform.

- Section 3 presents five cross pilot applications which will be used in all pilots and discusses the personalization and customization aspects that will be included in order to make the applications relevant for each pilot and specific target user group. Within the same section there is also an introduction of two applications related with WP4 developments and how they will link with the Waternomics Applications Platform.
- Section 4 starts by presenting an overview of the Linate pilot in relation to the applications developed and continues to describe the pilot specific applications.
- Section 5 starts by presenting an overview of the Thermi pilot in relation with the developed applications and continues by providing descriptions of the applications in more detail.
- Section 6, similarly, presents the overview of the applications used in the two different pilots in Galway and continues by presenting details of the different pilot specific applications
- After the presentation of all applications in Sections 3, 4, 5 and 6, Section 7 discusses the business value proposition of the different application under each pilot context and serves as a link with D7.4 to follow up with specific Business models and exploitation activities on M30.
- Finally, Section 8 summarizes the deliverable by highlighting the key innovations introduced in Waternomics applications.

1.5 About Waternomics

Climate change, increased urbanization and increased world population are several of the factors driving global challenges for water management. In fact, the World Economic Forum has cited “The Water Supply Crises” as a major risk to global economic growth and environmental policies in the next 10 years. In parallel, the United Nations has called for intensified international collaboration. To help reduce water shortages, Waternomics will explore the technologies and methodologies needed to successfully reduce water consumption and losses from households, companies and municipalities. Waternomics is a three year EU-funded project that started in February 2014 that will develop and introduce ICT as an enabling technology to manage water as a resource, increase end-user conservation awareness and affect behavioural changes, and to avoid waste through leak detection. In saving water, energy will also be conserved (treatment and pumping) as will the CO_2 associated with energy production. Unique aspects of Waternomics include personalized feedback about end-user water consumption, the development of a methodology for the design and implementation of systematic and standards-based water resource management systems, new sensor hardware developments to make water metering more economic and easier to install, and the introduction of forecasting and fault detection diagnosis to the analysis of water consumption data.

Waternomics will be demonstrated in four high impact pilots sites that target three different end users/stakeholders:

- Domestic users in Greece implemented in cooperation with a respective municipality
- Corporate operator in Italy provided by a major EU airport
- Public and Mixed-use based demonstration sites in Ireland

Through these contributions, Waternomics will pioneer a new dialogue between water stakeholders. It will enable the introduction of Demand Response principles and open business models through an innovative human centric approach that uses personalized water data, water availability based pricing, and gamification of water usage statistics. To maximize impact, the project highlights business development, exploitation planning, and outcome oriented dissemination.

2 The Waternomics Applications Platform (WApP)

2.1 Introducing Waternomics end users

One of the distinguishing aspects of Waternomics project is its wide variety of end users. Indeed, Waternomics has four pilot sites to test and validate its research, data platform and applications. Details about the pilot sites will be discussed later in this deliverable. However, in this section we simply describe the end-users for each of these pilots:

1. **Linate pilot:** Linate airport in Milan, Italy. This pilot targets corporate users that are staff members of the airport ranging from building mangers, technicians and engineers as well as other staff members. These are adult users that have an advanced level of education and skills to work in such environment. Besides staff members of the airport, target users also include passengers that range from a wide variety of casual to business travellers from different age groups from kids to adults.
2. **Thermi pilot:** Households from Thermi, Greece. This pilot target domestic users. Families are the main users that include kids, young adults and adults.
3. **Galway pilot:** Public spaces in Galway, Ireland.
    a. **NUIG Engineering Building (NEB):** Engineering school in Galway, Ireland. This particular pilot site targets at the same time (1) staff members: managers, technicians and researchers, and (2) students: undergraduate and research students. While staff members are interested in understanding water usage behaviours and detecting saving opportunities, students are interested in visualising the building consumption and use consumption data in their projects and research works. The age groups of this pilot site range from young adults to adults.
    b. **Coláiste na Coiribe School (CnaC):** Secondary school in Galway, Ireland. Similar to the Engineering school site, target users are staff members and school students. The main difference is the age groups which are ranging from kids to adults in this site.

Figure 2 summarizes the user groups of Waternomics project.

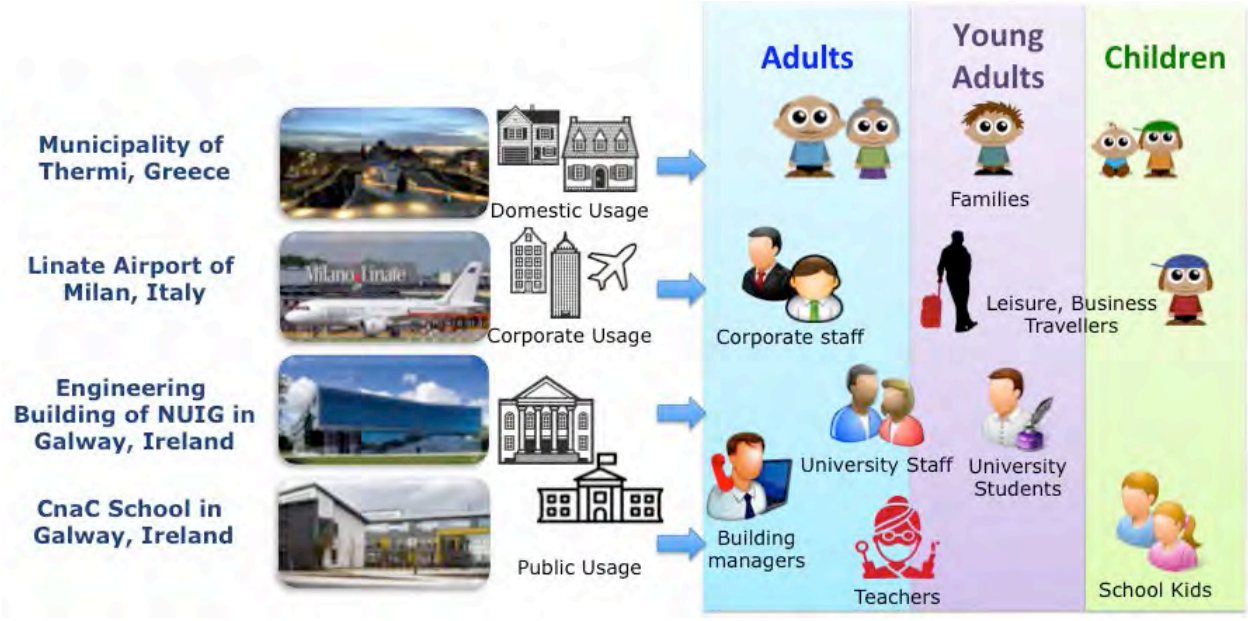


Figure 2: Waternomics target user groups

2.2 Introducing WApP as an Applications Market Place

Based on the requirements and KPI's presented in D1.3 the project conducted a set of various user tests with users in all pilots and the main outcome from these tests was that it would be very difficult to construct one application that will meet all the needs for each pilot user (Kouroupetroglou et. al. 2015). Moreover, even within the same pilot there are users with different requirements. The persona design process that followed described the range of users we are dealing with all pilots and made clear that what was needed was a set of applications designed and targeted for specific user each time.

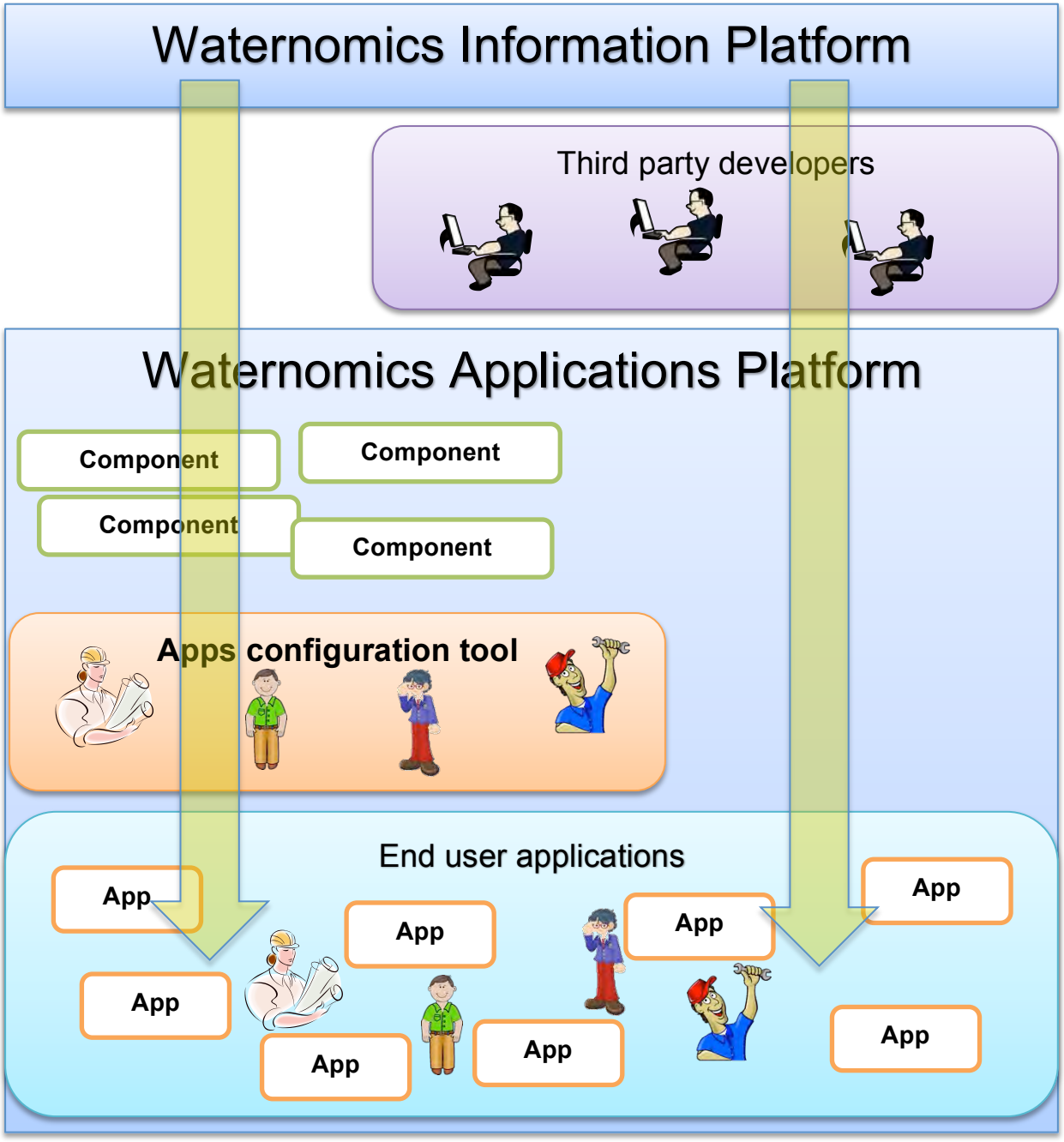


Figure 3: The Waternomics Applications Platform concept

In order to provide a common area for all of those different applications it was essential to build a platform where users will be able to find and use those applications based on their needs. The applications platform apart from the basic function of concentrating all developed applications in

one central place also provides a set of innovative ideas transferred from other domains of ICT to the water related industry.

Figure 4: The users' installed applications list

The applications platform itself as a concept draws an analogy with the already familiar concept of marketplaces that many of the mobile and web ecosystems offer today such as the Apple's AppStore[1], Android's Google Play[2], Chrome Webstore[3] etc. From the user tests it was made evident that even the not so tech-savvy users are familiar with the concept of this type of marketplace and can understand its functionality. Therefore, it was decided that in order to serve all the specific and detailed needs of users we should follow an approach of creating multiple simple apps focusing on specific needs that combined can meet the different set of needs for each and every user.

Apart from the flexibility in covering a wide range of needs, the Waternomics applications platform was designed so that it can also provide some additional benefits to its wide range of users as presented in 2.1.

[1] https://itunes.apple.com/us/genre/ios/id36?mt=8
[2] https://play.google.com/store
[3] https://chrome.google.com/webstore/

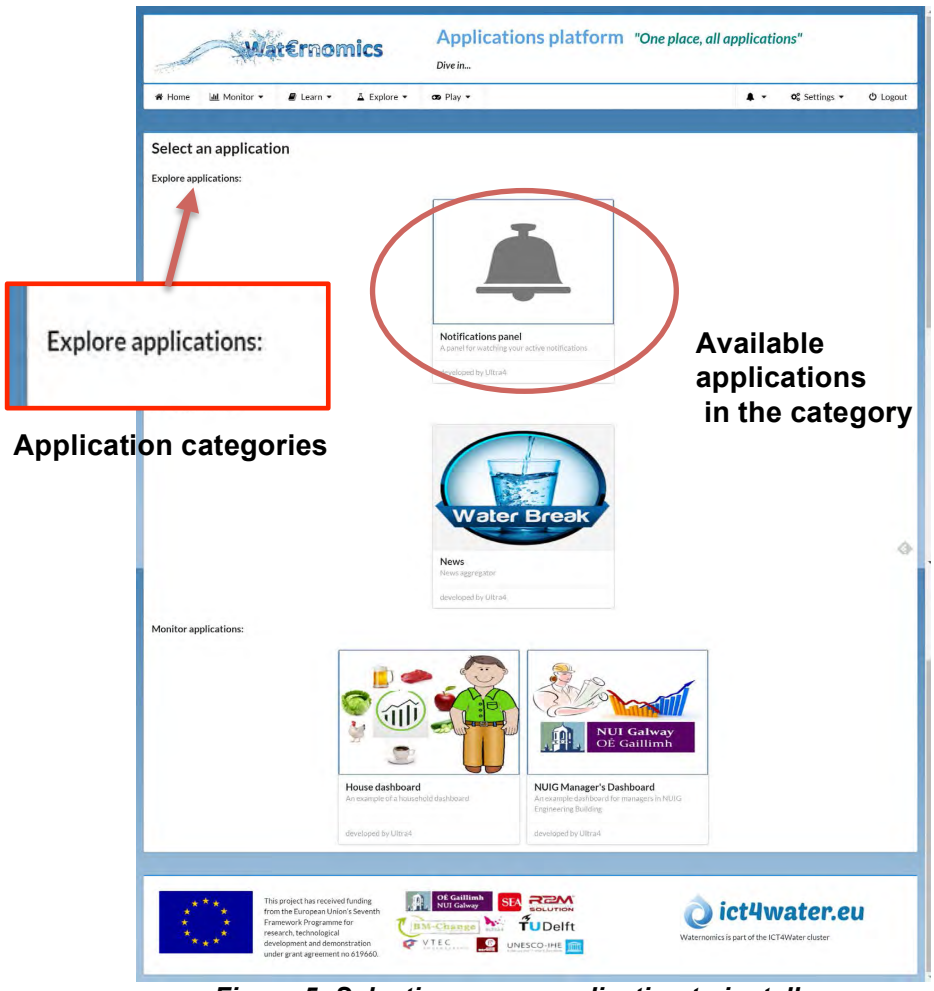


Figure 5: Selecting a new application to install

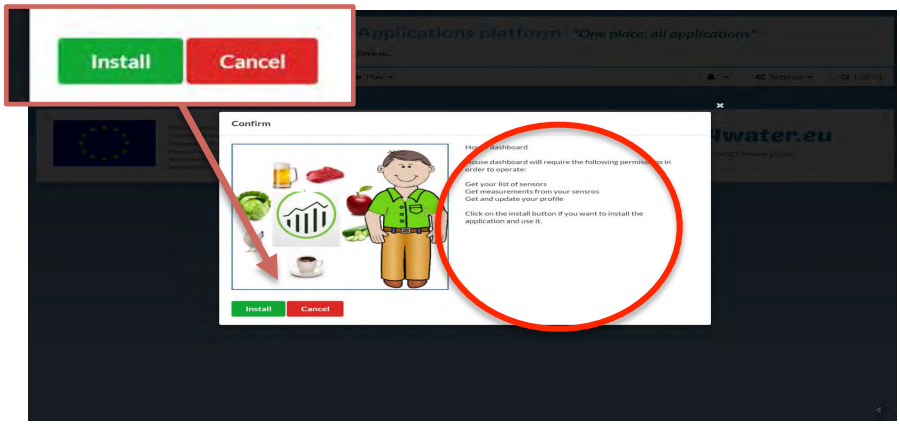


Figure 6: Confirmation of installing an application

2.2.1 Benefits of WApP for end-users

As already presented Waternomics aims to serve a wide variety of end users. Therefore, **WApP has been designed to offer all end-users convenience and usability by providing the following** benefits**:**

One place to concentrate all applications needed
User only need to use one URL to use any application they like.

Simple selection and deployment of any additional application
As soon as the user finds an application that he wants to use its installation and usage is a matter of 2 clicks.

Single sign-in process across all applications.
There is one login screen for all applications and user management is based on the main Waternomics applications platform user management structure. By the term user management structure we refer to the set of groups, roles and users of the platform and their relations between them. This means that there is no need for each application to create a separate user management structure or for users to remember different user names and passwords for every application.

Applications categorization
Applications can be separated in categories based on their functionality to facilitate easier discovery. Categories in the Waternomics applications platform currently include the following:

Monitor: Includes applications that allow users to monitor their consumption and have it presented in meaningful for them ways.

Learn: Includes applications that provide educational and informative material to users. Given the wide variety of user roles and groups in the system having a common user management allows for such applications to filter and target news and material delivery specific for each users' needs.

Explore: Includes applications that allow users to explore the potentials of the dataspace in terms of analytic services and related applications. Many of the applications in this category provide a way to configure and run a service on the data gathered in the dataspace in order to notify and prompt the user for specific actions e.g. many of these applications are linked to the notifications feature that will be presented in Section 2.4.2.

Play: Includes gaming applications or applications with gamification elements that help user to learn and educate themselves through playing or through interacting with them in non-leisure contexts.

Applications targeted for the end-user
Based on a user's role, suitable applications can be selected as install options for specific users so as to best match applications to end users and encourage installation of the most useful applications.

Easy creation of custom user made applications
Users can create their own applications by mixing and matching from a variety of readymade components available on WApP. This is especially useful for creating custom made dashboards addressing specific needs.

Social collaboration in creating applications
Applications developed by end-users can easily be shared with other users in their groups and roles or users from other groups and roles as well. This way the dashboard created by an environmental manager in the airport can easily be shared and used by other environmental managers and technicians within the same airport in an effort to enhance collaboration though sharing of information.

Redundancy of applications.
Similar to other applications ecosystems, the Waternomics applications platform allows for multiple applications to be developed for a specific problem or need of a user. Therefore, it allows for the necessary redundancy of applications so that users can have more than one

options to select from. This way it also encourages the creation of an ecosystem of competitive applications in different domains.

2.2.2 Benefits of WApP for administrators

Administrators are the users who are responsible for maintaining and managing the necessary infrastructure of the WApP. Based on the organisation scheme and business models administrators can either be members of a user organisation such as the IT department of the Linate airport or members of a third entity which is responsible for managing the infrastructure such as U4 for Thermi's pilot. Either way, WApP has been designed to provide administrators with the following range of benefits to facilitate their work:

A single user management structure for all applications
All applications work under the same user management structure so the same set of roles, groups etc. can be used in all applications

Management of applications delivery.
Administrators can easily manage which applications are available to which users based on the user management structure.

Easy creation of custom made applications
Administrators can also create their applications based on ready-made components and target them to specific roles, groups or users.

Extensibility
Administrators can easily include in the market place new applications developed using the components provided by the platform or by third parties and target them to specific users.

2.2.3 Benefits of WApP for developers

WApP offers developers an accessible and forward looking system to developers providing:

Extensibility
One of the key reasons for selecting the marketplace approach was the extensibility it can provide for the platform. Third party developers can easily include their apps in the Waternomics applications platform and benefit from its facilities.

Easy discovery of third-party applications
Easier discovery of their application through inclusion in the market place ecosystem. Moreover there is no need to develop their own user management structure since they can use the single sign on process of the market place.

Data Accessibility
Apart from the role of a marketplace for end-users the Waternomics applications platform includes also links to applications and data sources that are included in the dataspace and developers can exploit and use in their apps. This way, it also serves as a toolbox for developers connecting them with appropriate linked open data sources

2.3 Key Features of the Platform

As already presented WApP provide its users a wide set of benefits. However, in order to provide some of the benefits discussed it employs a set of distinguishing key characteristics which will be presented in this chapter.

2.3.1 The apps configuration tool

One of the key features of WApP is that it enables users to create their own applications by using a set of components that can be customized to their individual needs. In order to achieve this, the components described in D3.2 are used as building blocks that are combined in a single screen based on selected layouts. To facilitate users in that process they are provided with a configuration tool for applications.

The tool is accessed directly from the applications market place where the user can click the button manage apps and then select either to build a new application or modify an existing one.

Since the user access it, the tool he can setup the application be repeating a 3 steps process. The process creates a row of information in the application that can contain different components. After creating a row of information the user can select to add more rows or save the application giving a name and selecting a category to place it under. From then on the application is available as any other application under the selected category. The 3 iterative steps are the following.

Step 1: Select a row layout.
In this step the user selects how the layout of the row will be. There are three choices separating the row in one, two or columns respectively.

Step 2: Select components
Having selected a row layout the user is presented with that and he is asked to define what kind of component he wants to display in each column. To do this he simply selects a column and then a component from the ones available in the configuration panel on the right hand side. After selecting components for all columns the user can proceed to the next step.

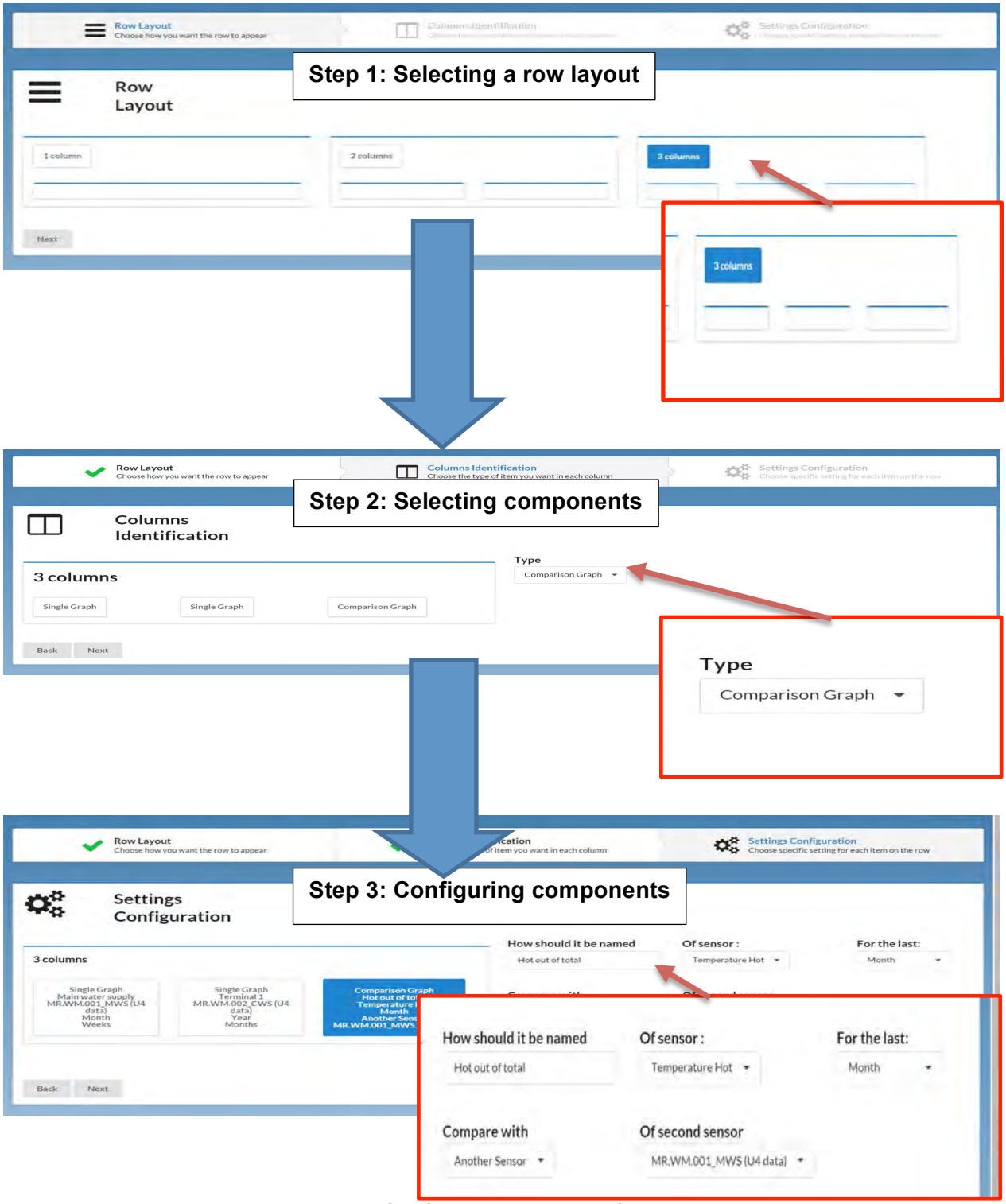


Figure 7: Configuration process flow chart

Step 3: Configure components

On the third step the user selects each of the components from the previous step and configures it through a series of selections based on the component. Apart however from the configuration that the user does for the component there are also personalization aspects that are considered when displaying the component to the user so based on the profile they might see a different version of the same component.

These three steps can be repeated for any number of times to create an application that can be tailored to specific user needs.

Finally the tool also allows the user, after creating an application, to share it with other users on the same or other groups. This way, as already mentioned, social collaboration between different users is encouraged and facilitated.

2.3.2 User customization of home page

Based on the user test interviews, it was clear that although there maybe broad agreement in terms of data that is useful and important the way in which end-users prioritize this data or like best to receive it, is very subjective. Some people for example like the idea of seeing a stream of events, similar to a social media feed, on the first page they see when entering the platform and others just wanted to focus on data and diagrams not caring about news or other information.

In devising a solution for this, we considered an option where the home page of a user entering the platform would show an application that they have already selected and installed so they can pick the one they liked. However, given the observation that most people had a basic prioritization on the most important information we opted to let the users decide what they want to see on their home page of the platform.

The ability for users to customize their home pages is accompanying and connected with the ability to create their own applications through the apps configuration tool. Since users can create their own applications and select which one they prefer to see in the home page it is easily understood that they can create a unique application for their own home page combining components from many other different applications. This way home page applications do not restrict users and allow them to create a home page application containing the most important information for them. Moreover, the ability to change their applications' configurations at any time allows them to also change the home page applications from time to time to include new and temporal interesting pieces of information (e.g. include a graph for the rain water harvesting measuring for the winter and autumn months only).

2.4 WApP cross-applications features

Apart from the distinctive key features presented in the previous chapter WApP also employs a set of features that are shared among all applications of the platform. These are the cross-applications features that are presented in this chapter.

2.4.1 User management and profiles

User profile information is an example of a shared feature and information across multiple applications. Such features can have access to user profile information and can also enhance with additional details if needed.

Domains: Domains in the user management system is an entity that separates different organizations or groups at the broadest level. The Engineering Building in NUI Galway would be a domain of which all staff and students based their could have membership, however their level of access and engagement with WApP will be defined by their role or membership of

Roles: A Role is an entity that can be used to group users across different domains. For example, a number users may be identified in the role of managers and these could include

managers from both the NUI Galway pilot site and from Linate pilot site. In the Waternomics application platform this allows for applications developed for one site to be easily targeted to groups in other pilot sites that have the same role.

Groups: Groups are more specific to a domain and allow the categorization of users within a domain. A user can exist in multiple groups and groups can also be connected with specific roles allowing the interconnection of groups in different domains based on the roles they have.

Users: Users is the final entity containing the information of a specific user with a username, password and all other properties that define a user in the management structure.

Sensor ownership: Given the description of Domains, Roles, Groups and Users the applications infrastructure also keeps information about which user has access to data of specific sensors to ensure privacy of data. A user can directly be connected as having ownership of a sensors thus being able to see its data but also they can be connected via a group that they belong to.

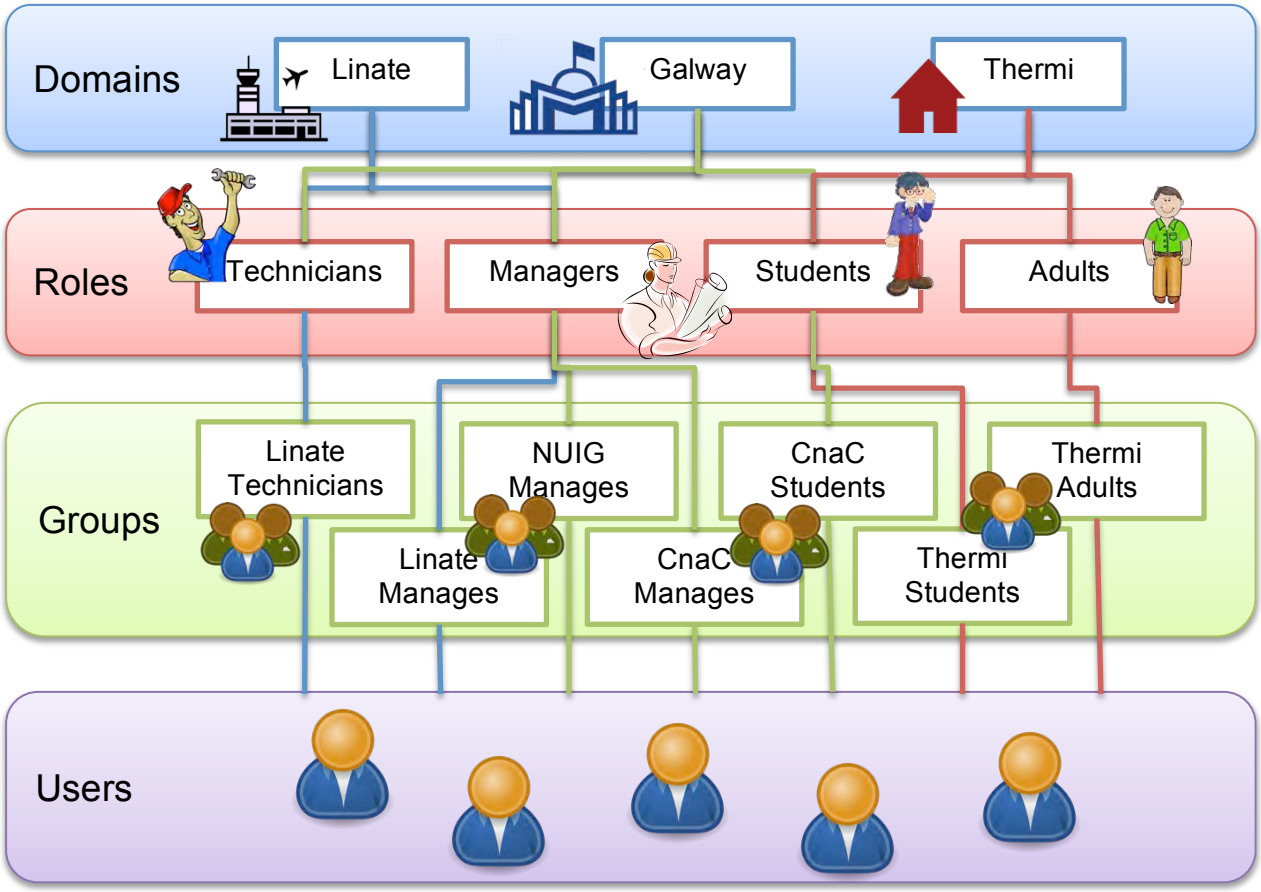


Figure 8: Sample of user management structure of WApP

2.4.2 Notifications

As already presented the idea of creating an applications marketplace fosters the creation of an ecosystem of applications around the Waternomics information platform. The approach as already explained allows applications to share some common datasets in order to avoid duplication, redundancy and finally creating multiple stand-alone applications. The user management structure is an example of how WApP shares common information with

applications in order to facilitate operation under the same environment by providing users with a unified and more pleasurable experience avoiding multiple accounts creation etc.

Notifications are another shared feature between applications. A key element in our discussions with users during the user tests was that users needed to be able to see notifications from all kinds of applications at any time (Acharya, 2016; Przybylski et. al. 2013). Notifications therefore needed to be a consistent feature across all applications in the platform. For example, if a user is using an application to read articles related to water conservation and a leak is spotted in a part of the network he needs to be notified immediately and access that notification as soon as possible. That is why the platform on its top main menu that is stays there for most of the applications displays an icon and a respective menu to check notification. That way if the user is in the platform and uses any application he can receive and access notifications from all other applications immediately. Moreover, when the user is not in the platform there are additional mechanisms employed such as emails and SMSs (see D3.2) based on the criticality of the notification that help reaching the user through other channels of communication.

As already explained in D3.2 the notifications component is using an API to allow applications to communicate with it and send their own notifications to the system. Notifications in Waternomics application platform are considered to be actionable pieces of information. This means that they usually require some action to be taken by the user. Therefore the concept behind notifications is that a user can remove the notifications from his list in three different ways.

1. Take the requested action and inform the system
2. Snooze the notification so that it will appear some time later on a more appropriate context where the user can take the action
3. Ignore and delete the notification without taking any action.

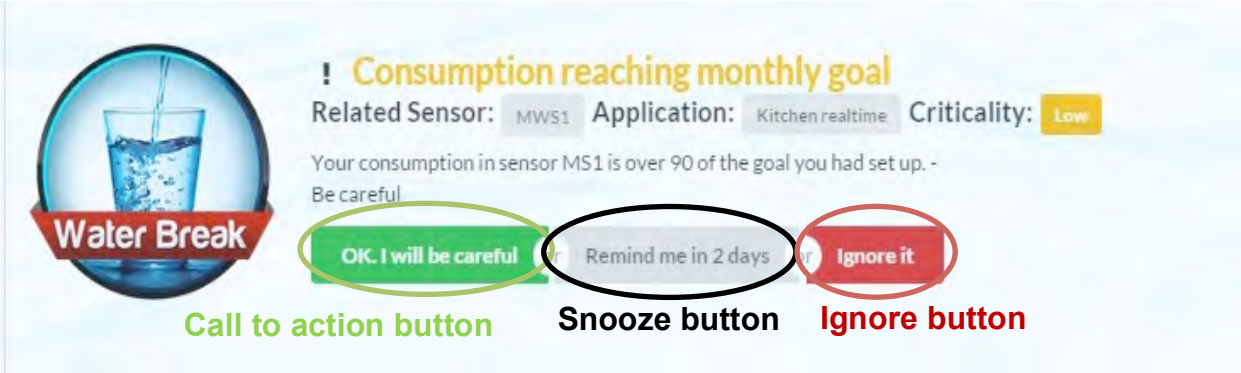


Figure 9: Screenshot of a notification with 3 actions

Given these three options, the notifications Applications Programming Interface (API) allows applications to handle the life cycle of a notification by providing also functions to mark a notification as being actioned, snoozed or dismissed. Finally the API also provides a function for getting the notifications based on a list of filters so that applications can also display and use the notifications for different purposes.

The notifications infrastructure also allows for social collaboration and even crowdsourcing actions to be taken by facilitating the sending of notifications to individuals or to a specific group as a shared notification (ul Hassan et al.). The concept of the shared notification relates to the request for a response from users of a particular group where only one person of the group needs to act on the notification in order to be marked as acted. To better understand where this kind of notifications can help a very illustrative example is the retention time observer application in the NUI Galway pilot applications. In this application, the manager can configure the system to send shared group notifications to specific groups to flush a potable water system for a defined minimum time period if the system observed a period of inactivity on a metered

system that is in excess of an allowable limit. This allows managers to both monitor and prevent water stagnation and potential negative effects on water quality.

2.4.3 Water Flavours

Consumption of the valuable resource that is water is a major concern from both financial and environmental perspectives. One of the objectives of Waternomics is to track the consumption of water and increase user awareness towards its usage. It is recognized that different users may have their own perception as to water usage quantities and simply showing them consumption volume water in units such as litres (L) or cubic metres (M^3) may not therefore be universally understood or have significant impact. Using metaphors, water footprints or costs is proposed as an alternative means to better visualize water consumption quantities (Cybulski, Keller & Saundage, 2014; Zapico, Guath & Turpeinen, 2010).

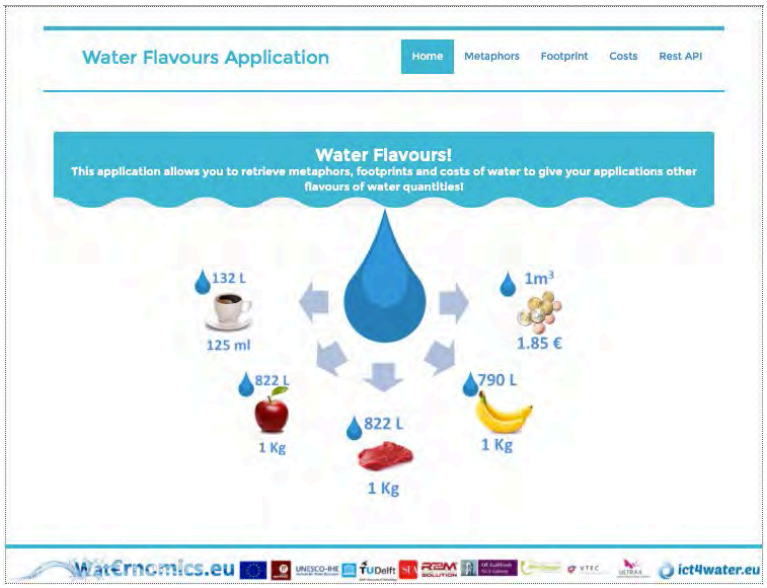


Figure 10: Screenshot of the landing page of the Water Flavours application

In this context the "Water Flavours" application has been developed in what serves as an intermediary between analytics services and end user applications (see the landing page of this application in Figure 10). It can be used to convert water quantities into other indicators such as prices of water (from a financial perspective) and water footprints such CO_2 emission (from an environmental perspective).

This application is a concrete example of using Open Data in the Waternomics project. Indeed, we are using www.waterfootprint.org as a main source of open data for water footprints. We are also using utility websites for water costs for each country either involved in the project or not. We are also using other open data sources that are also available in the Waternomics data portal WKAN (see details in D3.1.1 and D 3.1.2).

One of the main features of this application is that it is independent from any other application of the Waternomics Market Applications. It can serve as all Waternomics applications as well as other projects applications. Indeed, it offers a REST API that application developers can query to get the full list of metaphors, footprints and costs.

A user guide as well as details of the API can be found in Appendix 3: Water Flavours Application User Guide.

3 Cross pilot applications

Although needs were quite different from pilot to pilot and even within user groups of the same pilot, there were a number of needs identified as common ones across all pilots. This chapter presents those needs and the applications developed to meet them. It is essential to point out however, that although the applications presented seem to be the same for all plots there are differentiating details in the user interfaces and user experience for different users[1]. Moreover, this chapter contains a number of applications to be connected with developments in WP4 concerning leak and fault detection applications.

3.1 Monitoring stations control panel

Motivation:
A common need identified by all users in all pilots was the one of getting different kinds of information in a timely fashion. In the following chapters we are going to present a number of applications such as dashboards and notification control panels which play a significant role in meeting this need. However, most of them require from the user to enter the application to get the information. Monitoring stations is the application developed to ensure that important information for users is never missed. It allows users to set up a number of rules to get notifications when specific events related to their water consumption happen. Since notifications can be delivered through multiple channels this application creates a link back to the applications that is enabled whenever needed.

Description:
This application has a very easy and simple user interface since it is not aiming for user to return to it often. However, it serves a control panel where they can set up rules for different events that they want to receive notifications about. Rules are using sensor data and notify the user accordingly.

Based on the pilot site and different user profiles a different set of rules can be adjusted for every user. In general the application will become increasingly useful the more data are being collected from sensors and the richer the set of data becomes. Therefore the observatories control panel will start with providing user with a basic set of rules that they can setup and will gradually introduce more rule types as the data set available form sensors become richer in terms of timeframe and users get accustomed to them by the dashboard applications.

The application aims to provide a measure for avoiding information overload and creating a number of dashboards for each user that will eventually not be used. Whenever the user realizes that a specific piece of information in the dashboard in not any more of interest, though this application he can maintain connection with that information but on a need to act basis. It aims in providing users with piece of mind and taking gradually large part of their responsibilities.

[1] Part of the user customization and personalization is that the applications described in the next sections might not be found in the platform with the exact same names. For example the monitoring stations control panel can be named as “Monitor stations manager” for managers and at the same time named as “Keep an eye on…” for domestic users. Names will depend on the terminology used by users and will be largely decided by them.

The application is in line with a trend in new applications to interact with users mainly through notifications rather than try to make them return back without reason. Notifications are becoming therefore an essential part of any such system by providing users with information whenever they needed based on their context (Acharya, 2016).

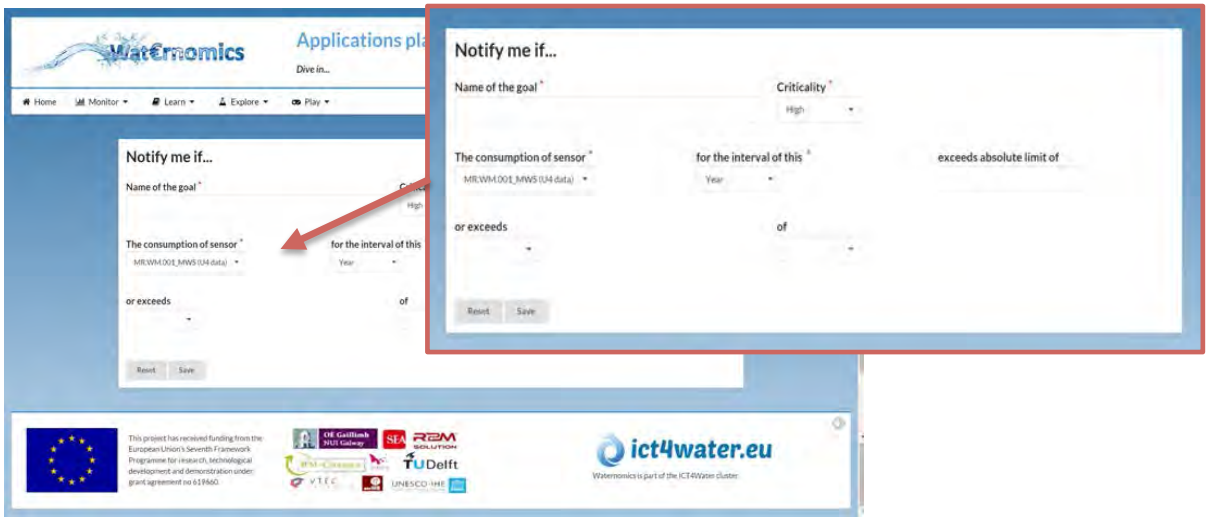


Figure 11: Monitoring stations control panel app

At a first stage the application will allow users to get notifications based on comparisons

- Between same sensors or group of sensors measurements with a respective past period (e.g inform me if the incoming water in DMA6 for this month reaches 90% of the previous month)
- Between sensors or groups of sensors (e.g. inform me if the hot water consumption reaches more than 30% of the cold water consumption)

Between users or user groups (e.g. this is specifically targeting the Thermi pilot where comparisons can be made between families)

- Between different usages (e.g. dishwasher vs hot kitchen tap water which is mostly used for dish washing)
- Of a specific sensor or groups of sensors with a given goal measurement (e.g. inform me if toilets' consumption is more that 10 m3 for the current week)

Given a richer set of data more advanced rules can be constructed such as setting up notifications if a sensor or group of sensors exceeds a predicted amount of consumption for a period (e.g. inform me if I exceed the predicted monthly consumption in the airport's male toilets.)

Highlights:

- Setting up notifications on specific events to avoid information overload.
- Gradually richer set of notification types
- Following the trend of smart contextual applications that run on the background and interact with users through notifications whenever needed.

Category: Explore

Dataspace data used:

- Consumption data from sensors
- Sensor descriptions

3.2 Social feedback and News aggregator

Motivation:
A crucial part of the Waternomics project is to facilitate in sharing knowledge and the creation of communities that can help each other through this exchange of information. To facilitate this exchange we opted to use existing social media and social bookmarking tools explained in more detail in D3.2 in order to create links with communicates of users outside the Waternommics consortium. This link allows for Waternmomics user to gather interesting information from outside sources as well as share knowledge with the rest of the world. The social and news aggregator application aims specifically to facilitate this interaction.

Description:
Section 5.5 of D3.2 presented how the social components library aims to integrate different news and social media resources under the common umbrella of a content repository where content form a variety of sources is gathered and categorised using tagging mechanisms of already widely used social media or social bookmarking services.

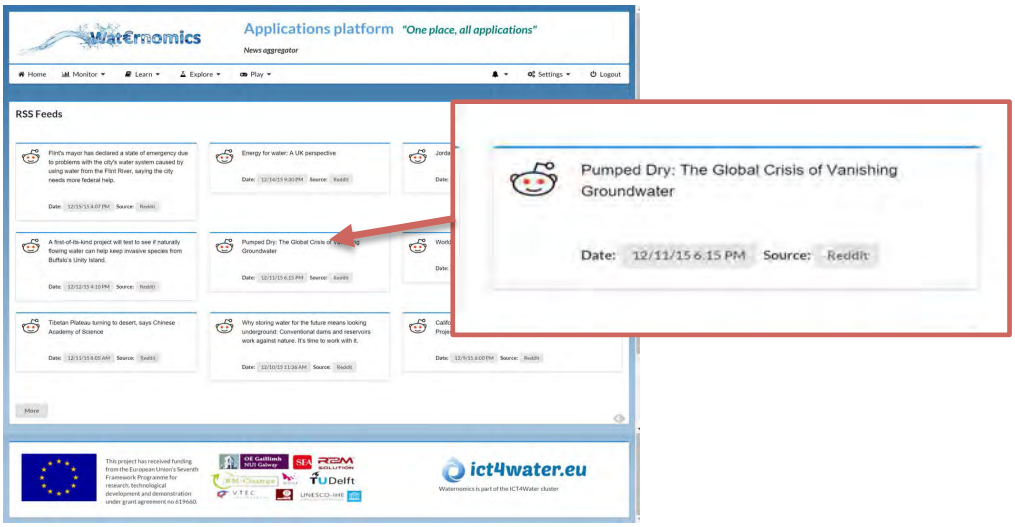


Figure 12: Screenshot of social feedback and news aggregator application

Having such an infrastructure ware experts around the world and not only within the consortium will be able to contribute to a global content repository by also helping in targeting content to specific use cases and users. A campaign will be conducted using social media, blog posts and a newsletter so that such experts will follow up in tagging or publishing related content with specific tags that will lead them to be gathered in the repository (Peters, 2016).

The social and news aggregator is an aggregator that is consisting of a sole component instance of the respective timeline component presented in D3.2. However, users will be offered a set of tags from which they can select and filter the displayed content. Moreover, filters will also be applied to content prior to users' selection based on their user profile and group where they belong in order to make sure that content that finally reaches to them is the most relevant possible given the supplied information from users.

Therefore the social feedback and news component, although the same in terms of layout and presentation for all user, it will differ dramatically in terms of content presented offering this way a high degree of personalization.

Highlights:
- Exploiting social media and social bookmarking sites to transfer knowledge between users

- A mechanism to validate and select quality content by related water experts not only within the Waternomics community.
- Using social media as a news source information

Category: Learn

Dataspace data used:
- User profile information

3.3 Water savings calculator game

Motivation:
Even in business environments such as the airport one gaming and gamification elements were identified as an interesting and potentially engaging element for users. Moreover, as it is pointed out in numerous studies one of the main game changers in the water conservation area can be the behaviour change in terms of our everyday habits which in some cases might not be mentally related to water for most of the users. When buying a hamburger for example from your favourite fast food chain very few people realize the amount of water actually needed to create that tasty burger. The water savings calculator game aims exactly at that. To make this mental connection to users minds by using a simple question and answers game and to provide easy tips for changing behaviours that will affect positively water consumption (Zapico, Guath & Turpeinen, 2010; Cybulski, Keller & Saundage, 2014).

Description:
The water savings calculator is a simple questions and answer game that uses specific water saving scenarios as the basis for a set of math questions asking the user to calculate their savings over time if they take specific actions. In order to make more personalized the game in the first stage the game usually asks the user for some relevant parameters such as the number of persons in their family, or the number of times per day they do a specific action.

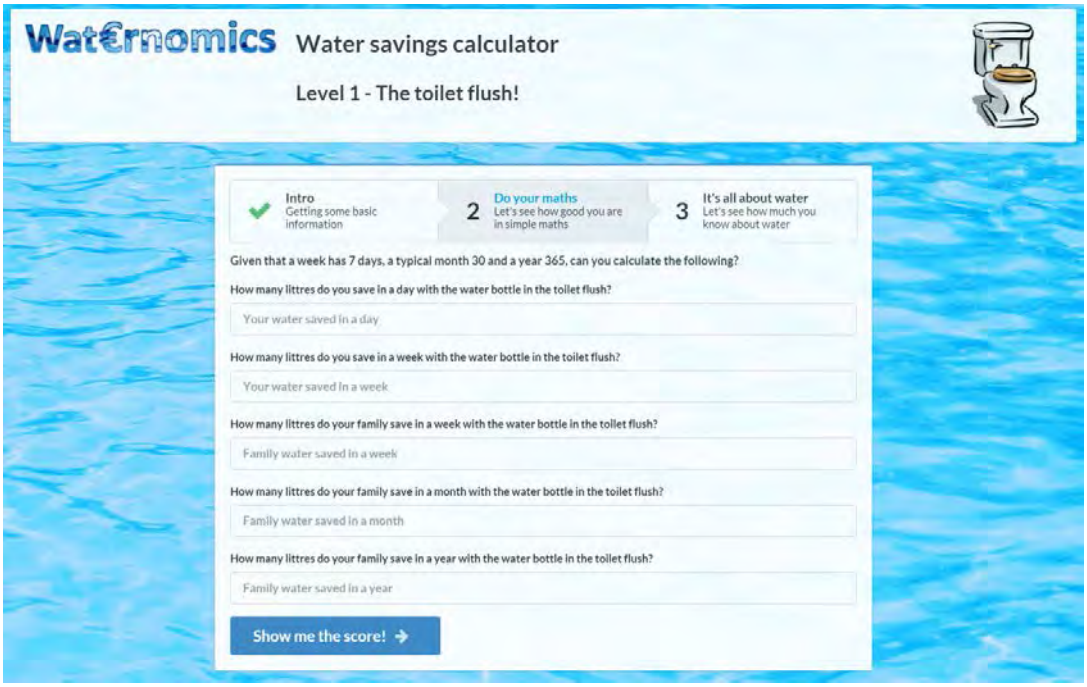


Figure 13: Screenshot of the water savings calculator game

Given these personal parameters the game proceeds by producing a set of questions that ask the user to calculate their water savings for specific time periods (e.g. How much would you

save if all of your family use the water efficiently during tooth brushing?). In this way users are forced to think and calculate the amount of times that in some cases seems insignificant for them.

Having answered the questions the game calculates a score based on how close their answers were on the actual calculation and then proceed to the next step which connects these amounts with actions, products and equivalents that aim to surprise the user. Users are asked through a set of multiple choice questions to guess what is the equivalent of the amount in other measurement units, in terms of water footprint or cost (e.g. In a month you would same use 100 litres.litres This amount of water could produce a) X kgs or cucumbers b) Y kgs of chicken meat or c) Z kgs of cereal.) This stage forces the users to make connections between their water savings and their impact in the environment. Therefore it helps in creating stronger mental connections of water consumptions with products and actions seemingly unconnected with water consumption. Moreover, the connection works in the opposite way as well. Users are also helped to force connections between water consumption and product or actions that are at first glance irrelevant aiming to affect their lifestyle in general.

In the end of the second set of questions users are also receiving a score based on how close they got to the correct answer and their final score is calculated. Based on the different pilot the scores can be used in different ways. In the cases of Linate and Glaway pilots the application will be linked from the public display application allowing users to complete their names and participate this way in a leaderboard of the game for the specific pilot. In the case of Thermi pilot users will be also linked directly with specific sensors in their households so this can also be connected with their own leaderboard applications.

Highlights:
- Combining Maths training and water awareness through a game
- Using water flavours to attract interest around water consumption and water footprint.
- Based on scenarios that can be selected based on user profile

Category: Play

Dataspace data used:
- Water Flavours
- User profile information

3.4 Drought conditions

Motivation:
The user tests conducted in the design phase of the applications among other things tried to identify how information about drought can affect users' behaviour. In general this is a piece of information that users in all pilots miss although organisations such as the European Drought Observatory (EDO) already provide it freely. Users in general expressed an attitude towards thinking more there water consumption if they knew that there was a drought period in their area. The drought conditions application aims exactly at that. To notify users of drought periods in an attempt to affect their behaviour during those periods. At this point it is interesting to point out that users across all pilots expressed the same attitude although in some cases (such as in Thermi) their water availability is not affected by drought periods.

Description:
The drought conditions monitoring application is actually based data provided by the European Drought Observatory (EDO)[1]. A service is set up to download those data in specific interval and scan for the drought conditions indicators especially for the areas of the three pilots. Based on the information gathered by EDO the service sends a notification to the WApP through the notifications API.

A more detailed analysis of how the drought conditions monitoring application is working and structured will be provided in D4.2. However, in this deliverable we have already presented the actual front-end of the application since it will mainly communicate with the applications platform through notifications. Therefore the main interaction point of the application with users will be either the notifications panel for the Thermi pilot or the Notifications control panel for the Linate pilot and through the wearable infocentre for the Galway pilot.

Highlights:
- Using EDO data to notify users of drought conditions in their region.
- Attempting to raise awareness on drought conditions and indirectly affect their behaviour during those periods.

Category: Explore

Dataspace data used:
- EDO indicators

3.5 Leak Detection

Motivation:
Leak detection was a need identified in all pilots especially in domestic environment where there is no detailed measuring mechanism and updates on water consumption where received through bills every 3 months. As part of the work done in WP4 is the development of innovative sensors for leak detection through sound signals detection (Seyoum, et. al., 2015). The development of the sensor includes both a hardware and a software part therefore there was a need to accommodate the application developed for the leak detection within the WApP. After consultation with members of the consortium developing the software for the leak detection it was decided that the best possible end-user interface for the outcomes of the sensors would be the notifications mechanism with its accompanying interface.

Description:
Leak detection application will be in combination with the sound based leak detection sensors developed in WP4. The software of the sensor is communicating with a service that checks the sound signals for matches with leak sound signals that have been recorded in order to identify potential leaks in the network.

A more detailed analysis of how the leak detection application is working and structured will be provided in D4.2. However, in this deliverable we will present in the next chapters the actual front-end of the application which similarly with the drought conditions monitoring it will mainly

[1] http://edo.jrc.ec.europa.eu/edov2/php/index.php?id=1000

communicate with the applications platform through notifications. Therefore the main interaction point of the application will be same as for drought conditions monitoring.

Highlights:
- Sound based leak detection sensors.
- A simple approach of interacting with users only whenever there is need to do so

Category: Explore

Dataspace data used:
- Sample leak sound signals

3.6 Automated Fault Detection Diagnostics

Motivation:
Similar to leak detection especially for organisations managing complex water network systems there was evident a need for Automated Fault Detection Diagnostics tools to help them in managing their water networks and detect faults at their earliest possible stage in order to reduce maintenance costs and improve efficiency of water supply systems. For this reason work conducted in WP4 deals with the development of 2 different approaches in fault detection and similar to leak detection there was a need for an interface of the applications with end-users. Once again as in the leak detection the notifications mechanism is employed for that (Clifford et. al., 2015; Chambers et. al., 2015).

Description:
Automated Fault Detection Diagnostics (AFDD) can be separated in two major categories; rule based and a model based (AFDD). In the Waternomics context two pilots are going to use two different approaches to develop AFDD applications.

AFFD is a measurement science used to detect faults at their earliest possible stage in order to reduce maintenance costs and improve efficiency of water supply systems. Water meters that were in place at the time of construction of our pilot site at the Engineering building, NUI Galway in 2011, along with recently installed ultrasonic meters supplied by project partners VTEC will be used to establish a baseline for water usage in the Engineering building. A baseline of water usage can be utilised to provide initial AFDD. If the baseline threshold is exceeded on any given day the building manager can be notified about the possibility of a fault through the WApP and respective notification related applications. The primary use of the Engineering building as an undergraduate teaching facility adds a complexity to this process, as a baseline out of academic term time must be established separately, along with the distinct treatment of weekends.

Some issues with the meters require data cleansing procedures. The daily record length is checked to ensure the meter was functioning properly for the entire day and that the quality of the data is adequate. Sense checks are carried out to establish if the recorded volumes of water are justifiable and sensible, i.e. does the number of daily showers estimated based on the daily volume of water used seem plausible. Issues also arise where the rainfall harvesting for the toilet flushing at the pilot site was inactive due to a fault for long periods at a time, therefore care must be taken to separate the analysis of these periods as toilet flushing uses a significant proportion of the buildings water usage. These separate baselines will be implemented in the Waternomics Platform through a set of FDD rules, which will allow notifications to be sent when abnormalities in the water network are detected.

The second AFDD application will be deployed in the Linate pilot and will be based on the ADWICE algorithm. The ADWICE algorithm is based on modelling the system selecting the best set of parameters that characterize the operational conditions (in our case they can be the flow

rate, pressure, energy consumption for pumps system, ground water level for the wells, etc.) assuming normal operation, i.e. absence of problems (leaks, faults, etc.). This model will be used as a comparison baseline with the operational values observed by the water sensors installed in the network in real time. Whenever the system under observation is not found to be operating in the modelled normal region and the deviation between the normality and the current situation exceeds a certain threshold, an alarm is raised.

One way to explain this process in a good visual is depicted in the following figure:

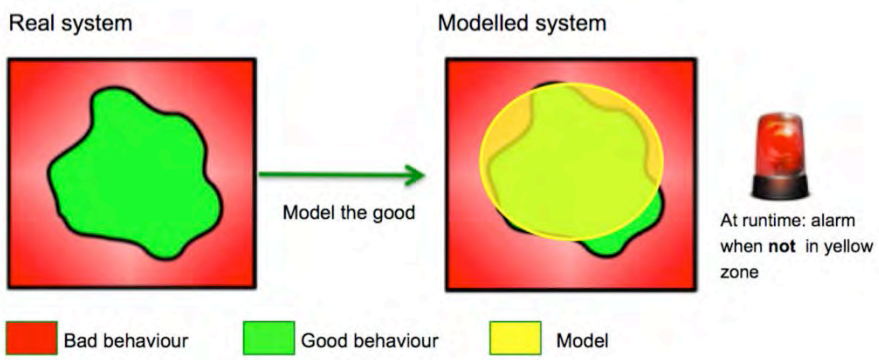


Figure 14: The Anomaly Detection model

Highlights:

- Two different fault detection algorithms deployed for different pilots.
- A simple unified approach of interacting with users only whenever there is need to

Category: Explore

Dataspace data used:

- Consumption data from sensors
- Data analytics results from Water Analytics service

4 Linate pilot apps

4.1 Overview

Linate pilot serves a variety of users in a business environment each one having a specific role in the company's structure. For some roles water related information is more crucial than others and in some groups information provided in a timely fashion is crucial while others can check details more casually. Moreover, apart from company's employee a major objective defined in D5.1 is the improvement of SEA's corporate responsibility profile through environment awareness raising actions. In order to satisfy the wide variety of needs for such an environment a set of 4 pilot specific applications will be introduced to its users accompanied with the 5 cross pilot applications. Table 1 presents how these applications meet the requirements described in D1.3, which objectives described in D5.1 they help achieving and which user groups they target.

Table 1: Overview of Linate pilot applications in relation with D5.1 objectives and target user groups

Objective / User group		Pilot specific applications				Cross pilot applications				
		Manager's dashboard	Notifications control panel	Technicians dashboard	Public display	Observatories control panel	Social and news aggregator	Water savings calculator game	Drought conditions monitoring	Leak and fault detection
D5.1 Objectives	Increase Water Awareness	X		X	X	X	X	X		
	Reduce water / energy consumption	X	X	X		X				X
	Improve water management and decision making	X	X	X		X	X		X	X
	Promote environmental responsibility				X		X	X		
User groups	Airport Manager	X	X			X	X		X	X
	Consultant / Designer	X					X		X	
	Public Relations	X			X	X	X			
	Technicians		X	X		X	X		X	X
	Passengers				X		X	X		

4.2 Manager's dashboards

Motivation:
Linate currently employs a quite complex system comprised of manual readings on paper, excel spreadsheets and many other types of information related with their water consumption. It is evident that environmental managers need a way to access information from all sensors in one place and be able to focus their attention on specific sensors or groups of sensors while at the same time get useful comparative information. That is exactly the need that dashboards created with the apps configuration tool in WApP can meet. Managers can organise information in a set of dashboards containing relevant information and focusing on specific aspects of the water management process each time.

Description:

Managers' dashboards in general try to apply already existing design rules for information dashboards in general (Choudhury, 2013; 2014). Instead of one dashboard application for managers in Linate and given the ability to create your own application as a user, the managers' dashboard can be considered rather a family of applications than a specific application itself. One of the key indicators managers in Linate wanted to follow is the comparison between incoming and outgoing amounts of water for specific areas. Therefore some of the applications designed for them are focusing heavily on comparison graphs displaying various comparisons between groups of sensors in incoming and outgoing points of the network.

Figure 15: Example of a manager's dashboards

On the other hand, managers are also interested in seeing the consumption over specific periods and being able to track and forecast the consumption in the next periods. Therefore, another key element usually used in manager dashboard applications of Linate is historical graphs displaying the consumption in specific sensors or groups of sensors for a given time frame. Managers can easily follow this way their patterns and combined with the comparison graphs take proactive measures whenever needed. Moreover, summaries of the graphs will display the total amount of water consumed in standard measuring units (m3) and provide estimates for the cost of water consumed and CO2 emissions.

Finally, Linate pilot is the only pilot where apart from flow meters there are going to be some pressure and energy consumption meters will be installed. Given that for pressure, managers are mainly interested in the current value, gauge graphs displaying current values will be also provided for them. Moreover, energy will be able to be represented in more or less the same way that as water consumption, is going to be presented using bar or line charts and also displaying the historical timeline of it.

Highlights:

- Fully customizable dashboards designed by the managers themselves
- Ability to create multiple dashboard applications serving specific needs
- Ability to share specific dashboard apps with other users to facilitate collaboration and communication

Category: Monitor

Dataspace data used:

- Consumption data from sensors
- Sensor descriptions

4.3 Notifications control panel

Motivation:
One of the main objectives for Linate pilot is to improve network management operations by assisting operational staff of the airport to coordinate and make better informed decisions when deciding on task to undertake. To improve coordination of actions operational staff needs a way to get short and action-related information from the platform. Notifications provide the ideal mechanisms for such delivery of information. Moreover, apart from receiving notifications the operational staff needs a way to track their operations and measure their improvement or not. That is why the notification control panel as an application combines multiple notification related functionalities. Users can see notifications and their statistics in terms of time until an action was taken and in parallel they can also create new custom notifications.

Description:
The notifications control panel is an application that gives overview on status of all notifications within a timeframe. Based also on the activity logging on different notifications the user can see how much time did it takes from the time of creation of a notification to the time of taking an action or deleting it. The application also allows to filter notifications based on the group they were targeting, criticality level and the source application for that in order for users to be able and extract important information on how quickly and efficiently they manage notifications.

In the airport environment it is crucial for managers to track and handle how users / employees in the airport respond to different notifications. This was evident from the user tests, especially for the operational department employees since there is no organised way of tracking operations and response times. The notifications control panel allows managers to not only show but generate custom notifications themselves to give instructions and issue tickets for repairs to specific groups or users.

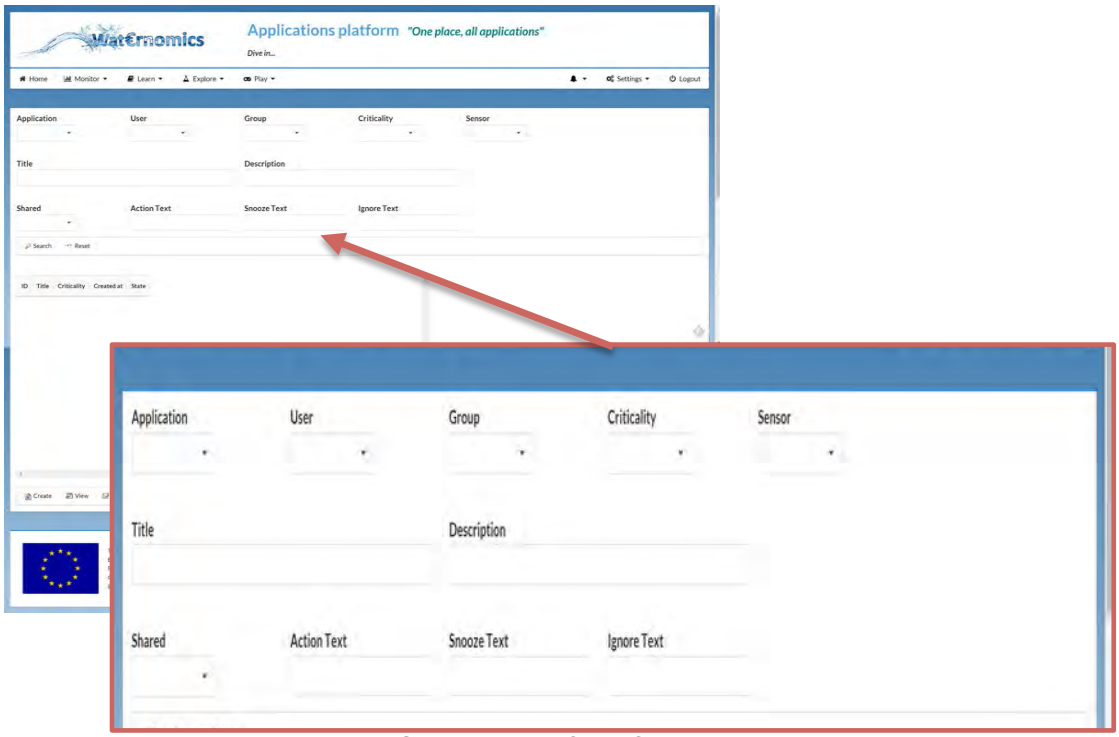


Figure 16: Screenshot of notifications control panel

Highlights:
- Custom notification creation and targeting for users
- Reporting on performance of users based on response times

- Notifications are used as an internal ticket handling system for operational employees

Category: Explore

Dataspace data used:

- The application provides an interface for managing Notifications that can originate from any application which uses data from the dataspace. So, indirectly the application can potentially be using all kinds of data provided by the dataspace.

4.4 Technician's dashboard

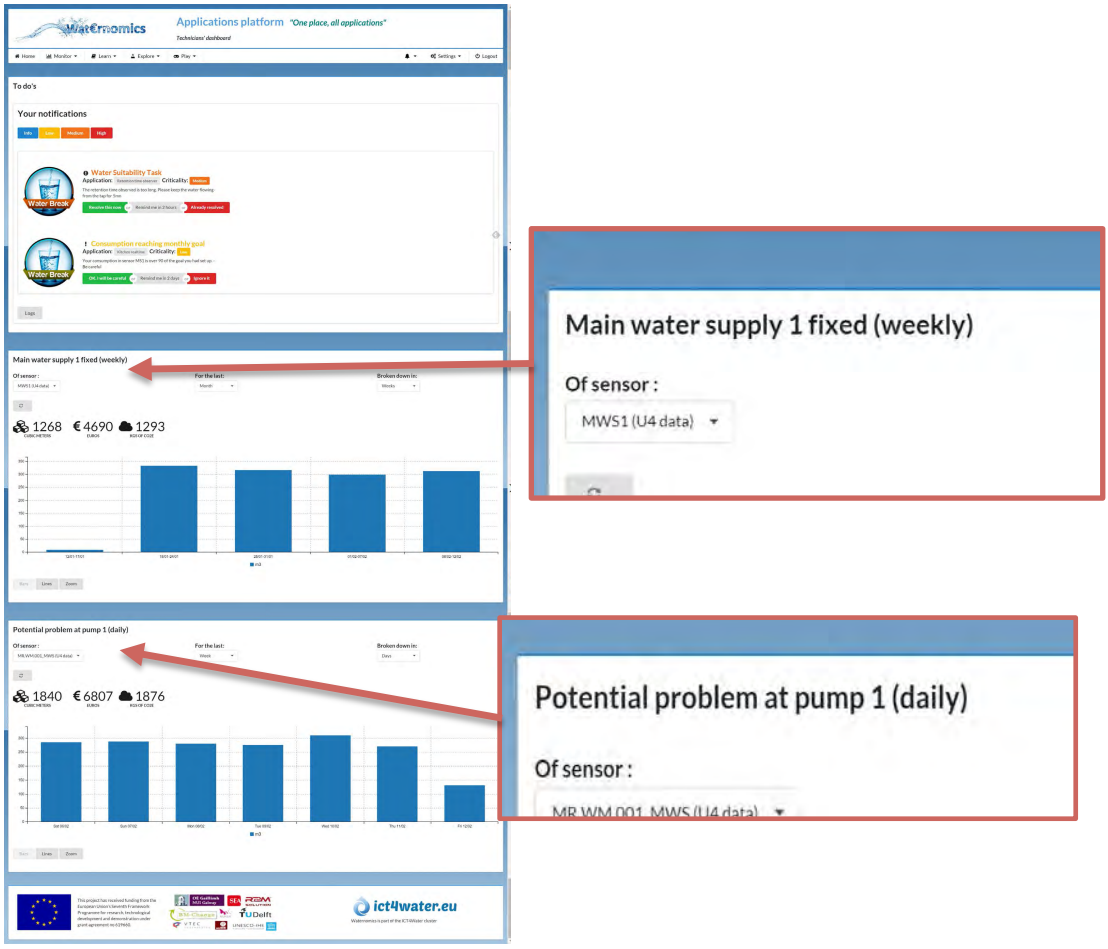


Figure 17: Example of a technician's dashboard

Motivation:

Technicians have quite different needs from managers in what they need to see in their dashboard. A crucial part of their dashboard is the notifications aspect where they need to check what kind of notifications have been directed to them from various applications and act on them. Apart from notifications which is the main focus area technicians also want to follow specific measurements from period to period based on their operations at the time, so some very specific diagrams for consumption and other measurements are also crucial for them. Finally, a key characteristic of technicians work in the airport is that it is highly mobile. Technicians do not have much time to be in an office and in front of a computer, therefore dashboards created for them should also be focusing on critical aspects and be able to be checked easily through mobile devices.

Description:
Therefore part of their dashboard is the list of notifications that exist in the notifications control panel. In this case however, technicians need to report mainly on their actions and it's not necessary for them to create new notifications for other users. So there is no need to include this part of the notifications control panel in their dashboard. This way the application provides a quick and easy way to get updated on what needs to be done, filter out the most important jobs and prioritize on tasks in hand based on criticality levels of the different notifications.

In addition technicians also need to be able and follow specific measurements of specific groups of sensors, to be aware of the changes introduced in the system after their operations. Therefore, their dashboard also needs to include a limited number of specific graphs helping them to follow up on specific problems and repairs.

As mentioned this part of the application is quite dynamic and will need to changes from time to time. Knowing how to use the configuration tool will help them configure the appropriate diagrams below the list of notifications. Moreover, the diagrams also include control to change dynamically the displayed graph without the need to get to the configuration tool every so often. So for example a technician might set up a historical graph to show the measurement of the sensors in District Meter Area 6 of the airport on a weekly basis for the last month to follow up repairs that have been made in the area but he could easily change the time line of the diagram using the controls accompanying the graph component.

In this specific application it is important to stress out that the whole WApP is designed using responsive web design practices that enable such web apps to be displayed in mobile devices as well as in desktops and tablets. Therefore, all applications using components of the platform are responsive and adjust accordingly in smaller screens by stacking up components used in the same row based on the order of appearance. Technicians in the airport are highly mobile and this requirement is very important for applications such as this.

Highlights:
- A unifying application between metering data and notifications
- Enabling quick overview of important information with a quick glance
- Taking under account mobility of technicians

Category: Monitor

Dataspace data used:
- Consumption data from sensors
- The application provides an interface for managing Notifications that can originate from any application which uses data from the dataspace. So, indirectly the application can potentially be using all kinds of data provided by the dataspace.

4.5 Public display

Motivation:
One of the main Waternomics objective is to reach the users providing them with useful information and tips to improve their global behaviour about water consumption. Linate airport is an optimal place in which to convey messages about water resources and involve users due the fact that the airport is dedicated, the predominant part, to a clientele of type " frequent-flyer " on particular routes attraction, national and international and it present an high number of passengers traffic. That is why in Linate there will be an installation of three touch screen displays in the most frequently used airport areas.

Table 2: Passenger traffic for 3 years

Year	Movements	Passenger
2010	96.200	8.200.000
2011	91.100	9.000.000
2012	90.800	9.000.000
AVERAGE VALUE IN THREE YEARS	92.700	8.733.000

Description:
The interactive touch screen displays will be equipped with a web based app developed with the double objective to convey information about project and to make interact the users by giving them information about the importance of the water resource, water footprint, tips to show them how to improve their water consumption, information about how the Waternomics project will impact on the Airport infrastructure and games to calculate in real time the users' water footprint.

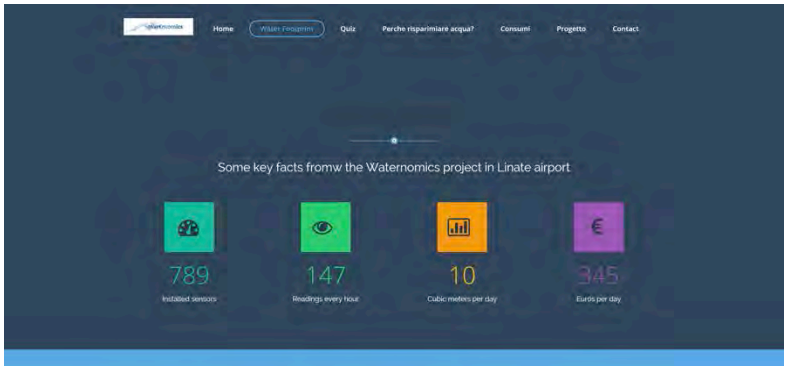


Figure 18: Part of the Linate public display app

Figure 19: The touch screen display tested in the ECOMONDO fair (Rimini – Italy 2015) and ready to be installed in Linate pilot

Basically the web based application is divided into seven sections:

Video Section: The starting point of the web based application will be a video. Its objective is to highlight the main achievements of the Waternomics project in an attractive and cosmetic way.

Carbon footprint and water footprint: This section has the purpose to highlight the involvement of SEA Corporate in environmental issues. So it will provide also the basic definition of water and carbon footprint.

Quiz section: This section will allow the users to test their water footprint in real time by showing them simple questions about their lifestyle habits.

Tips on how to get a reduction of our water consumption: This section is designed to engage consumers in new interactive and personalized ways that bring water efficiency to the forefront and leads to changes in their water behaviours. In order to achieve this the section will

stress the importance of water as a resource to preserve and will suggest some simple tips to help users in doing this in their everyday life.

Linate airport real time water monitoring section: This section is designed to show to the users the real time water network monitoring implemented in Linate Airport with the Waternomics project. Some information about water injected in the network will be provided in a simple way. To engage and improve understanding of water consumption the data from the sensors will be translated using some related water flavours.

More information about Waternomics project: This section is designed to provide more detailed information about Waternomics project in order to increase the users' interest in water related issues.

Comments and Waternomics newsletter subscription section: This section is designed to give the opportunity to the users to leave a personal feedback about the Waternomics project and to invite them to subscribe to the project newsletter.

Highlights:
- Providing generic information about the project combined with data from measurements
- Respecting very tight privacy regulations of SEA
- Raising awareness with connection to other public applications such as the water savings calculator game.
- Increasing corporate responsibility profile of SEA

Category: Monitor

Dataspace data used:
- Consumption data from sensors
- Water Flavours

5 Thermi pilot apps

5.1 Overview

The pilot in Thermi aims at domestic environment users. The main differentiation in that environment is this between adults and children in a family although different households have different priorities and incentives for participating in the pilot. However, this differentiation is mostly accommodated by the customization of applications towards each specific households needs. In this pilot the objectives of reducing water consumption and raising water awareness are also accompanied by the objective of changing users behavior and promoting education. In order to achieve this many of the applications make an extensive use of features related with the water flavors concept that helps in creating cognitive links of water consumption with seemingly irrelevant concepts and actions through water footprint data and other tangible water container equivalents. Moreover, a more informal tone in the communication of application with users is adopted in most applications and gamification elements and gaming applications are more prominent than in the Linate pilot discussed earlier. Finally, another distinctive key characteristic employed in applications for Thermi is the comparisons with peers in terms of consumption in order for users to understand where they stand compared with social standards. As explained in many cases this is a quite strong motivator for many people to take specific actions and in Waternomics we are exploiting this heavily in the Thermi pilot.

Table 3 presents an overview of the applications developed for Thermi pilot together with cross-pilot applications and indicates how those meet with objectives of D5.1 and which users they target.

Table 3: Overview of Thermi pilot applications in relation with D5.1 and target user groups

Objective / User group		Pilot specific applications				Cross pilot applications				
		Family dashboard	Water consumption timeline	Notification panel	Leaderboards	Observatories control panel	Social and news aggregator	Water savings calculator game	Drought conditions monitoring	Leak and fault detection
D5.1 Objectives	Increase Water Awareness	X	X		X	X	X	X	X	
	Reduce water consumption	X		X		X				X
	Behavioural change	X	X		X	X	X	X	X	
	Promote education						X	X		
User groups	Adults	X	X	X	X	X	X	X	X	X
	Children	X			X		X	X		

5.2 Family dashboard

Motivation:

Given the wide variety of metering plans followed in each household it is easy to understand that family dashboards will be quite different from family to family. Households in Thermi currently receive information about their overall consumption over a period of three months every time they receive the bill from the water utility. Therefore a key element families were usually interested in was to follow is their consumption over specific periods and how this is distributed in different uses in the household, so that they can track and understand their behaviour better. Family dashboards aim to do just that. Provide information on a timely fashion and with more detail than an overall amount of consumption.

Figure 20: Example of a Family dashboard

Description:
Each family will design their own family dashboard or select one based on pre-defined templates. Therefore, depending on their needs and sensor installation each family will be able to see a customized dashboard for their needs. Moreover, same as with the managers' dashboards families can also create multiple dashboards for specific needs. So, family dashboards can be considered rather a family of applications than a specific application itself. As explained, one of the key elements families were usually interested in was to follow is their consumption over specific periods and how this is distributed in different uses in the household, so that they can track and understand their behaviour better. Therefore, a key element usually used in families' dashboard applications is historical graphs displaying the total consumption from all household sensors for a given time frame. Especially in the two households where meters are going to be installed in the main supply this historical graphs can display the measurements on that point.

A distinctive characteristic in families' dashboard from managers' one is that in historical graphs summaries of the consumption will be provided not only using standards measuring units (m3) but also by using a set of metaphors either describing equivalents amounts of water or respective amounts of products that could be produced based on the water footprint organisation data provided by the water flavours service described in D3.1.2.

Another very important piece of information missing form families was the distribution of their consumption over specific outlets. Therefore distribution graphs based on the location or water outlet will be used in most of the households as a key ingredient in their dashboard.

Finally, comparison graphs can also be used in some families to provide comparisons between different consumption periods or points in order to help users understand better their behaviour and experiment with water saving strategies.

Highlights:
- Unique setup of dashboard for each family based on their needs and metering plans.
- Increased features focusing on raising awareness through water flavours.
- Comparison with peers

Category: Monitor

Dataspace data used:
- Consumption data from sensors
- Sensor descriptions
- Water Flavours

5.3 Water consumption timeline

Motivation:
Graphs and diagrams are a very usual way of communicating information to expert users such as managers in buildings such as the airport. However, diagrams may not always be understood easily by end users and crucial details might be missed. On the other hand, domestic non-expert users are quite familiar with the timeline-feed concept which is highly utilised in social media applications. So, this application is a transfer of the social feed paradigm in the water consumption domain. It tries to communicate key characteristics and statistics of their consumption based by a creating a feed of event automatically created by the platform.

Description:
As explained, this application is a transfer of the narrative or social feed paradigms in the water consumption domain (Quigley, 2016). The application is using a single respective component of the timeline as presented in the D3.2 with the difference that apart from seeing events from social media accounts the user can set it up to create events for him based on his consumption.

The application initially focuses on showing simple short summaries of someone's consumption by comparing it to previous consumptions or other similar measurements. For example it can be set-up to describe the users' weekly consumption in the kitchen in relation previous weeks consumptions and the average of kitchen consumption values form all other participant households. The result is that the user has a feed that is automatically populated with new events every week including a short summary of how he did compared to his own previous consumption and other households.

The summaries are presented in short textual descriptions that can easily be shared on social media. The application allows that to happen by also suggesting a set of hashtags that can be used for that reason. The application is develop so that it can be used to experiment different kinds of summaries and messages to investigate what is better to raise awareness in users. Therefore, messages appearing will be changed in the future to test out which version had better results in engaging users and raising awareness.

Highlights:
- Event (narrative) based presentation of data consumption
- Social feed like design providing short stories on weekly and monthly consumption
- Easy to connect and share on social media

Category: Monitor

Dataspace data used:
- Consumption data from sensors
- Sensor descriptions

5.4 Notifications panel

Motivation:
Domestic users do not exhibit the same kind of interest for notifications and their completion or not statistics as manager and operational staff in bigger organisations. However, they do need to keep track of the active tasks that have been sent to them as notifications and try to resolve them in any way they can. This is why we decided to design an applications specifically targeted for domestic end users allowing them to simply take actions on their notifications similar to what happens in a typical to-do list application.

Description:
Notification panel in the domestic environment structure can be considered as a subset of the notification control panel provided to managers in the airport environment. In this case however, the panel focuses on active notifications. Users can opt in to show notifications that have been acted or dismissed by selecting appropriately from the filter selection.

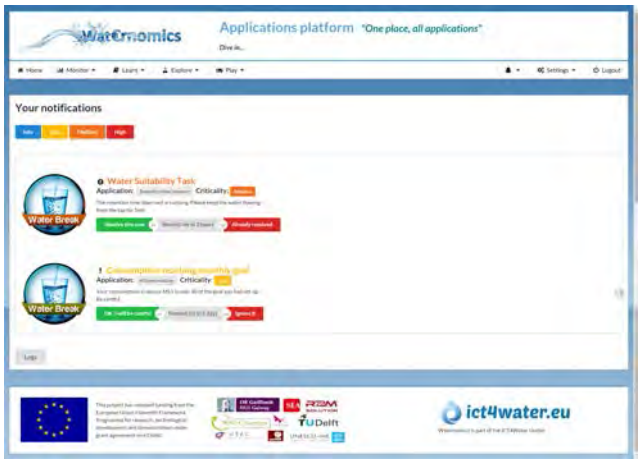


Figure 21: Screenshot of notifications panel

This application uses the notifications panel component described in D3.2. The goal of the application is an additional point of reference for notifications apart from the indicator in the main menu of the WApP. It focuses on tasks in hand and tries to make the user act on as many as they can. In order to engage more users the notifications panel will exploit using the empty state to the specific application to communicate messages to the user that will encourage them to change their behaviour (Brandall, 2016).

Depending on their last actions when users achieves a zero-notifications state a message will appears that is customized depending to the last actions of a user in order to encourage more actions to be taken and reward users when doing so with some humorous pleasant message. For example in the case of dismissing most of their latest notification the message could be something that points to the fact in a subtle, humorous and surprising way.

Highlights:
- Notifications as a to-do list
- Subtle gamification aspects by keeping users actions
- Elements to provide with pleasant and smart UX

Category: Monitor

Dataspace data used:
- The application provides an interface for managing Notifications that can originate from any application which uses data from the dataspace. So, indirectly the application can potentially be using all kinds of data provided by the dataspace.

5.5 Leaderboards

Motivation:

One of the main concepts of Waternomics applications is the exploitation of games and gamification elements to increase engagement and awareness of water consumers. Leaderboards is once again a family of applications aiming to connect gamification elements with actual consumption measurements. Moreover, it aims to enhance social interaction between participants by allowing them to compare with others and identify strengths and weakness in their consumption (Peters, 2016).

Description:
Leaderboards is a family of applications such as dashboards that developers can exploit to create competitions between individuals or groups of users. Given that all households will have a similar installation in the kitchen, including metering in the kitchen tap and the dishwasher, one of the first example leaderboard applications will be a leaderboard of families based on their per capita kitchen consumption. Each family will have a group of users that will be able to check the leaderboard and how their family is doing in them.

The scoring will be based on a weekly calculation of the per capita consumption in the kitchen and ranking of families according to that. Based on that ranking, points will be awarded according (e.g. 20 points for the first family, 18 for the second, etc.). Given the scoring system families will gather points and every month there will be a monthly champion. To include a reward as a incentive for the participant families, Thermi municipality will (after family's consent) publicize their achievement in local press and media.

Similar to the kitchen leaderboard there are going to be similar leaderboard for other comparable consumption points such as between families that are measuring their washing machine consumption or bathroom tap consumption etc. A similar scoring system will be deployed and a similar championship structure will be followed.

A key feature that aims to pleasantly surprise users is a set of predefined messages that will appear in the application every time they use the application. Messages will be connected with how well they are doing in the leaderboard and what is the user's role to increase personalization. In some cases they could also provide advices for improving their performance next time.

Leaderboards will be an application highly connected with social media so that users can post their weekly or overall achievements on social media. Once again a selection between predefined messages to share your achievements will be offered to users to help them in the process. Humour, relevance with context and personalization is aiming to engage users with the application and make them return.

Highlights:
- Introducing a very common gaming concept tied with real consumption data
- Exposing interaction of leaderboards with other applications
- Ability to participate either as a group or as an individual
- A variety of surprising, personalized and contextual messages will be delivered each time a user visits the application

Category: Play

Dataspace data used:
- Consumption data from sensors
- Sensor descriptions
- Water Flavours

6 Galway Pilot Sites Apps

6.1 Overview

Galway pilot has two important sites: the Engineering Building at NUI Galway and Coláiste na Coiribe secondary school.

The Engineering Building at NUI Galway (NEB for short) is a state of the art educational facility designed to be a 'living laboratory' where the building itself is an interactive teaching tool. The Engineering Building opened in 2011, it is the largest engineering building in Ireland and includes lecture halls, classrooms, offices, laboratory facilities, a café, and showers and bathrooms.

Figure 22: NUI Galway Engineering Building

The building accommodates approximately 1,100 students and 100 staff in 14,000 m2 of floor space on four floors. The majority of students are undergraduates aged 18-24 years.

Coláiste na Coiribe (CnaC) is an Irish language secondary school with approximately 350 students and 25 teaching and administrative staff. The existing school is housed at a small city centre location. To facilitate the demand for places at the school and to address space pressures, a new 7,400 m^2 school is currently construction at a new sub-urban location in Galway

Figure 23: Coláiste na Coiribe Pilot Site

In the following, we present both the Engineering Building at NUI Galway applications and the CnaC applications as these two pilots share two main applications: public display and manager's dashboard applications for both sites have much commonality.

Table 4 presents an overview of the applications developed for Galway pilot together with cross-pilot applications and indicates where those meet objectives of D5.1 and which users they target.

Table 4: Overview of Galway pilots applications in relation D5.1 objectives and target user groups

KPI / Objective / User group		Pilot specific applications						Cross pilot applications				
		Goal-oriented accessing water	Public display	Manager's dashboard	Physical Consumption feedback	Water retention time observer	Wearable info centre	Observatories control panel	Social and news aggregator	Water savings calculator game	Drought conditions monitoring	Leak and fault detection
D5.1 Objectives	Increase Water Awareness	X	X	X		X	X	X	X	X	X	
	Reduce water consumption	X			X			X				X
	Improve water network operation			X	X	X	X	X	X	X	X	

KPI / Objective / User group		Pilot specific applications						Cross pilot applications				
		Goal-oriented accessing water	Public display	Manager's dashboard	Physical Consumption feedback	Water retention time observer	Wearable info centre	Observatories control panel	Social and news aggregator	Water savings calculator game	Drought conditions monitoring	Leak and fault detection
	Promote education		X		X				X	X		
NUI Galway User groups	President			X				X	X		X	
	Building Services Manager			X	X	X		X	X		X	
	Chief Technical Officer			X		X	X	X	X			X
	Consultants / Contractors			X								X
	Technicians			X		X	X	X	X			X
	Staff / Lecturers	X	X		X	X			X			
	Researchers (PG / PD)	X	X		X	X			X	X		
	Students	X	X		X	X			X	X		
CnaC User groups	School Principal	N/A		X	N/A	N/A	N/A	X	X		X	X
	Building Contractor	N/A		X	N/A	N/A	N/A	X				X
	Teachers	N/A	X		N/A	N/A	N/A		X	X		
	Students	N/A	X		N/A	N/A	N/A		X	X		

6.2 Public Dashboard

Motivation:
A key objective for both pilot sites in Galway is to increase water usage awareness in public spaces. To this direction setting a kiosk with an interactive dashboard can attract people and engage them with discovering water usage details of the building where they are. A public dashboard is a preconfigured web application that shows generic information of the site's consumption and related information such as consumption per student, toilet flushes per day etc. compared with social norms (Horan, et. al., 2015), based on events generated (Hasan et al.).

Description:
The developed application shown in Figure 24, serves as a communication medium to display the amount for water being consumed in various places in the building. This application uses the Water Flavours Application in order to show water volumetric values in other dimensions such as cost, metaphors and footprints. The image on left side of Figure 24 shows the amount of water in terms of number of standard size of water cooler bottles.

This application visualizes water quantities in circles using colours to indicate if the water usage is high, low or normal (see the upper part of the middle image of Figure 24). This application uses social media to inform users about the technology used within the Waternomics project, and its updates (see the lower part of the middle image of Figure 24).

Users can interact further with the application to explore the water usage data over a full month (see the upper part of the right side image of Figure 24) as well as get more details about technologies that used within the Waternomics project (see the lower part of the right side image of Figure 24).

Figure 24: Public Display showing water data from the Engineering Building at the National University of Ireland

The public dashboard application uses the Water Analytics Support Service for querying the data from the dataspace. This service has been extended to serve an extension of the public dashboard an allow users to explore further the water data by scanning QR codes near the sensors. As shown in **Figure 25**, users will be able to visualise the entire month consumption. This extension is mostly targeting students and researchers who also can retrieve the data from this service via its API to use in their projects or carry out further research.

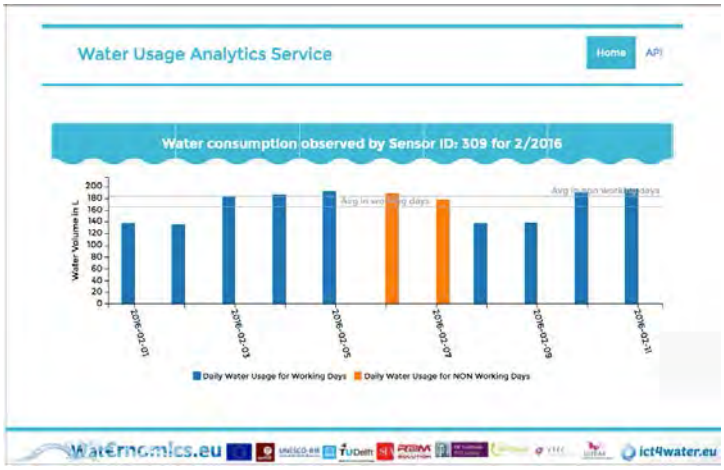


Figure 25: Visualizing Water Analytics for the sensor 309 in February 2016

Highlights:

- Target a large audience
- Increase water usage awareness in a public space

Category: Monitor

Dataspace data used:

- Consumption data from sensors
- Data analytics results from Water Analytics service
- Water Flavours
- Social media aggregator

6.3 Manager's Dashboard

Motivation:
Managers in NUI Galway Engineering Building and CnaC as in the Linate pilot are basically interested in watching the consumption in different points of the water network. Moreover, in contract with airport managers NUI Galway Engineering Building and CnaC managers would like to get information about related water flavours so that they can use them in communicating relevant messages to their students. Finally another critical aspect of their dashboards is to be able to track goals.

Figure 26: NUIG manager's dashboard example

Description:
As in both previous pilots, dashboards can be considered rather as a family of applications targeting specific needs for managers than as a single application aiming to solve all problems for all users.

As explained earlier managers in NUI Galway Engineering Building and CnaC are basically interested in watching the consumption in different points of the water network, thus one of the key elements used in their dashboards will be historical graphs showing the consumption in

various points or groups of interests. However, in contrast with airport managers NUI Galway Engineering Building and CnaC managers will also be able to see related water flavours so that they can use them in communicating relevant messages to their students.

Goal setting and tracking is also an important aspect for managers in Galway pilots so comparison graphs will also be an important part of their dashboards. Based on the dashboards and the information that they show them they can identify when they need to send particular messages to specific groups by using the notification control panel application deliver them appropriately.

Highlights:
- Providing users with vital information for communication with students
- Facilitating communication with users through notification control panels in the dashboards as components
- Usage of water flavours to facilitate the creation of messages to communicate to students.

Category: Monitor

Dataspace data used:
- Consumption data from sensors

6.4 Water retention time observer

Motivation:
In public spaces, making drinking water available comes with a major concern: is the water safe to drink. Currently, this can be guaranteed through a very well selected location of drinking water fountains in order to make sure that water is always flowing in the pipes in order to have fresh water most of the time. However, in spaces such as a university building, drinking water fountains can remain unused during long holidays and weekends. Consequently drinking water can reside for long periods in the pipes. Building managers want to make sure that that residing water is still safe to drink.

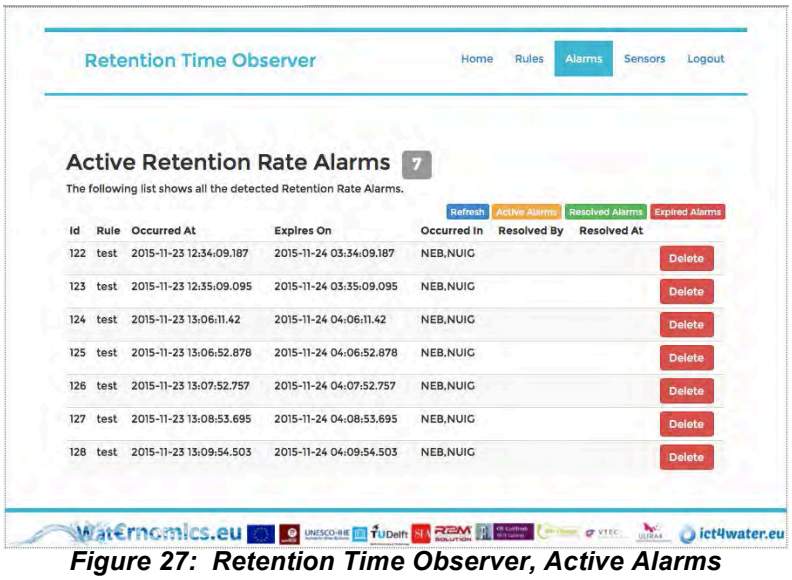


Figure 27: Retention Time Observer, Active Alarms

Description:
In this context, the water retention time observer application can assist managers to guarantee that they receive timely notifications regarding water that has been residing for a long period in drinking water pipes. This can be done by allowing them to set up a set of rules for tracking periods of inactivity in specific measurement points and automatically send notifications through the system to selected user groups. **Error! Reference source not found.** shows the list of test active alarms detected by the application.

The application is very well aligned with one of the objectives of Waternomics: giving actionable information to water users and managers. More details about this application can be found in Appendix 5: Water Retention Time Observer User Guide.

Highlights:
- Notifications regarding water retention time periods
- Managers can set themselves the acceptable retention time of a particular pipe

Category: Monitor

Dataspace data used:
- Consumption data from sensors

6.5 Notifications control panel

Motivation:
Similar to Linate pilot both Galway pilot sites also aim to improve network management operations by assisting operational staff to coordinate and make better informed decisions when deciding on task to undertake. Moreover, an additional aspect on the context of the Galway pilots is the ability to communicate messages and specific actions needed by specific student user groups (e.g. Consumption in male showers is quite high compared with our typical monthly consumption so please consider using water effectively while in the showers). Therefore, an application similar to the notifications control panel developed for Linate will also be deployed for Galway pilots.

Description:
The notifications control panel is an application that that gives overview on status of all notifications within a timeframe. Based also on the activity logging on different notifications the user can see how much time did it take from the time of creation of a notification to the time of taking an action or deleting it. The application also allows to filter notifications based on the group they were targeting, criticality level and the source application for that in order for users to be able and extract important information on how quickly and efficiently they manage notifications.

In the Galway pilots environments notification will also be used to communicate messages to specific user groups related with their consumption in order to require actions or encourage behaviour change. The notifications control panel allows managers to not only show but generate custom notifications themselves to facilitate this communication with specific user groups.

Highlights:
- Custom notification creation and targeting for users
- Reporting on performance of users based on response times
- Notifications are used as an internal ticket handling system for operational employees

Category: Explore

Dataspace data used:
- The application provides an interface for managing Notifications that can originate from any application that uses data from the dataspace. So, indirectly the application can potentially be using all kinds of data provided by the dataspace.

6.6 Wearable Info-centre

Motivation:
In contrast with managers in Linate managers at Galway pilots are much more mobile and similar to technicians in Linate they need to get notifications of important aspects of the water consumption in their building. In this case however, users are more technology friendly and expressed their willingness to use a more advanced mechanisms for receiving notifications through smartwatch devices. That is exactly the wearable info-centre application developed for them.

Figure 28: Wearable inforcentre, receiving notification from the water retention time observer

Description:
The wearable info-centre can be seen as a smartwatch extension of the notifications panel described for the domestic environment. The application is actually developed in two parts. One part is a mobile application for Android smartphones which is responsible for communicating with WApP and receive notifications through the notifications API.

The second part of the application is smartwatch application that the user installs on his smartwatch and gets the notifications received from the mobile phone application in order to display them in the smartwatch. This way users don't have to check on their phones every time they receive notifications from the platform but instead check on their watches which can be less obtrusive while communicating the information at any time. Figure 28 shows an example of using the wearable info-centre.

Highlights:
- Anytime, anywhere, notification for managers

Category: Monitor

Dataspace data used:
- The application provides an interface for managing Notifications that can originate from any application which uses data from the dataspace. So, indirectly the application can potentially be using all kinds of data provided by the dataspace.

6.7 Goal-oriented Accessing Water

Motivation:
One of the ideas exploited during the user tests was the concept of allowing users to track their own personal consumption patterns by applications that are activated and connected with specific micro-sessions of a user consuming water such as preparing coffee, drinking water, washing hands etc. (Kouroupetroglou et. al., 2015b). One of the key outcomes in our tests was that mobile and wearable devices can offer a great opportunity in personalized tracking but this is hard to do if it requires an additional action to already existing routine (e.g. if it requires you to get your phone out of your pocket and scan a QR code). So, in the goal-oriented accessing water application we are experimenting with the idea of replacing an action in this routine while in parallel giving some short pieces of information.

Description:
This concept challenges the centuries' old mechanism of operating a faucet, which in fact is a valve of various designs. The proposed new system will transform using water into goal-oriented activities that accessing water is no more just about enabling a valve. The entire system consists of three main components of which the left one engages with end-users and the right ones connects with the building manager. By setting up a touch enabled sink display next to a faucet (without its original turning knob) users are able to choose certain water activity such as 'one cup of tea' or 'one bottle of water. This message will be sent wirelessly to a solenoid valve connected to water pipe or faucet which provides certain amount of water. In this manner, users are always aware of his/her water related activity thus would have less chance in wasting water. A social network system is also implemented into the system such that users can report issues/problems to each other or even to the building manager so that urgent problems can be solved more rapidly to prevent waste of water in any case.

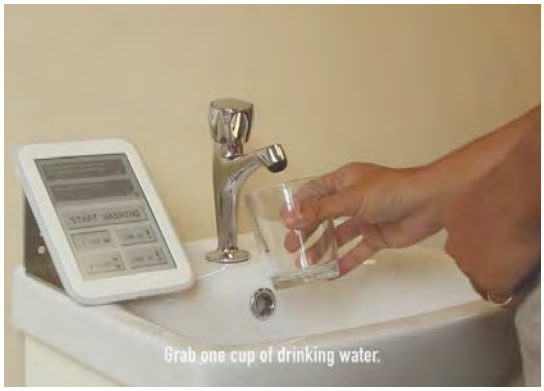


Figure 29: Goal-oriented Accessing water application

Please not that this application is developed for experimental purposes. It has not got approval to be part of a permanent installation of this pilot. For this reason, it is not fully integrated with Waternomics platform. Moreover, it is needed to point out that the application is comprised of a specific hardware and software and as such it is difficult for users to experience it remotely. Therefore, since WApP is actually a web portal of applications the application will be integrated by including a description of the installation with necessary information and instructions for replicating it in another environment.

Highlights:
- Water saving and awareness at a consumption point

Category: Monitor

Dataspace data used:
- Consumption data from sensors
- Water Flavours

6.8 Physical consumption feedback

Motivation:
As explained in the previous application one of the ideas exploited during the user tests was the concept of allowing users to track their own personal consumption patterns by applications that are activated and connected with specific micro-sessions of a user consuming water such as preparing coffee, drinking water, washing hands etc. As already explained communicating messages to users during that interaction with water can be challenging since it must not require users to change their usual routines. This application aims exactly at that point of communicating messages to users while they are interacting with water by using the water itself as medium to communicate messages (Kouroupetroglou et. al., 2015b).

Description:
An important goal of the Waternomics project is to increase awareness about water consumption and to inform users by providing actionable information about consumption. This

can be done via visual or sound indicators (i.e. a sound alert or when a certain level of water consumption has been reached).

The concept proposed in this application is to use the water itself as a means of communication about the volumes of water being consumed. Rather making a sound alert or illuminate a let near the water source, the water pressure changes to indicate that a certain volume of water has been reached. This concept is illustrated in Figure 30. The concept is based on findings from user research which showed that in general, users are motivated to save water and in most cases only need a reminder signal to change behaviour. Current research tries to validate this concept with the goals Waternomics. Managers can configure this application by using the control dashboard shown in Figure 31.

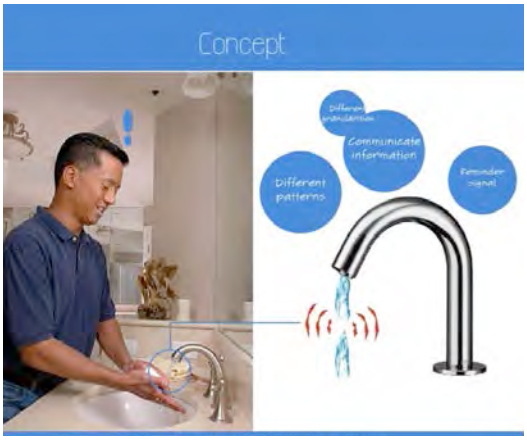


Figure 30: The concept of physical consumption feedback

Please not that this application is developed for experimental purposes. It has not got approval to be part of a permanent installation of this pilot. For this reason, it is not fully integrated with Waternomics platform.

Highlights:

- Use water flow pattern as feedback for the user

Category: Monitor

Dataspace data used:

- Consumption data from sensors

Figure 31: Control dashboard for the physical consumption feedback application

7 Pilot's Business Architecture

This chapter describes the business architecture of each of the pilot sites in order to gain a better understanding of the context in which the Waternomics applications will be deployed and to verify the alignment of the applications with the pilot organisation's strategic objectives. The Business Architecture Working Group of the Object Management Group (OMG) (2010) describes business architecture as "a blueprint of the enterprise that provides a common understanding of the organization and is used to align strategic objectives and tactical demands". Within Waternomics, the Essential Meta Model as developed by the Essential Project[1] is used to describe the pilot's business architecture, see Figure 32.

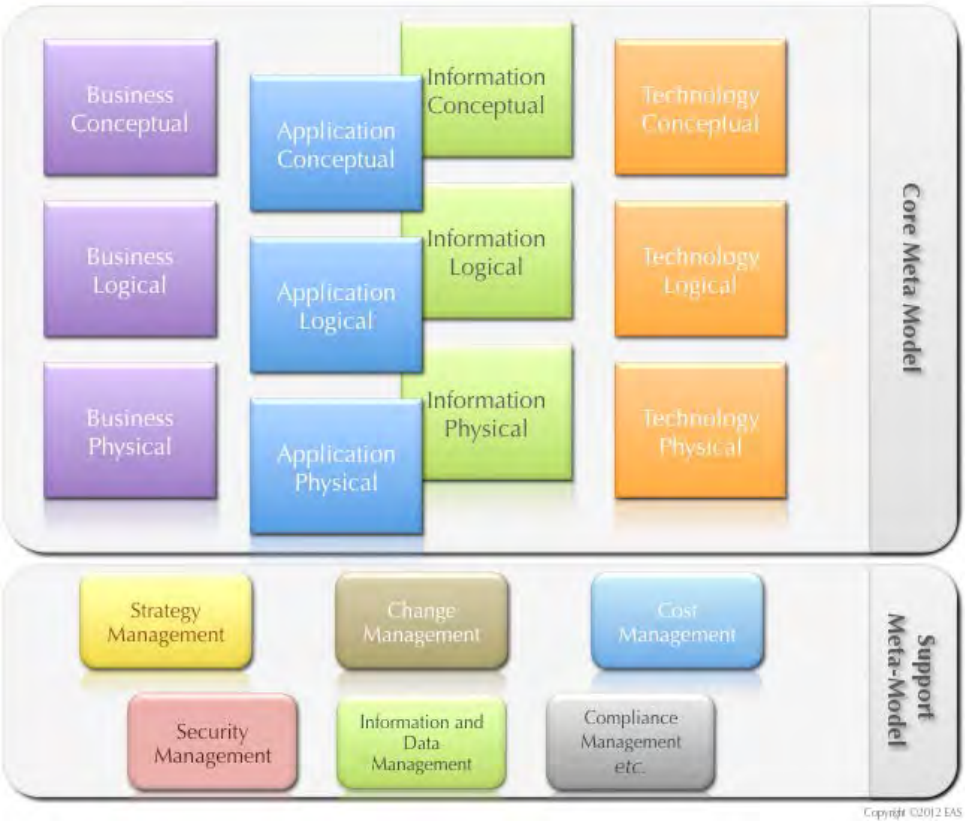


Figure 32: Essential Meta Model

The Core Meta Model's twelve classes are distributed across four layers representing the four areas of architecture and three rows representing three levels of abstraction.

The four architecture layers are defined by Essential as:

1. Business layer: Classes related to the objectives, capabilities, people and processes of the enterprise
2. Application layer: Classes related to the functional behaviour provided by technology systems.
3. Information: Classes related to the information that support business processes, is managed by applications and transmitted/stored by technology.

[1] http://www.enterprise-architecture.org/

4. Technology: Classes related to the software and hardware technology used to implement applications.

The three levels of abstraction are defined by Essential as:

1. Conceptual View: the capabilities and concepts that represent the fundamental elements needed to meet the objectives of an enterprise (Strategic Agenda)
2. Logical View: the approaches taken to realise the capabilities and concepts of the Conceptual View (Tactical Agenda)
3. Physical View: the implementation of the approaches described in the Logical View (Operational Agenda).

In addition, six Support Meta-Model classes enable management and governance processes.

The Business Layer consists of ten interrelated elements as shown in Figure 33.

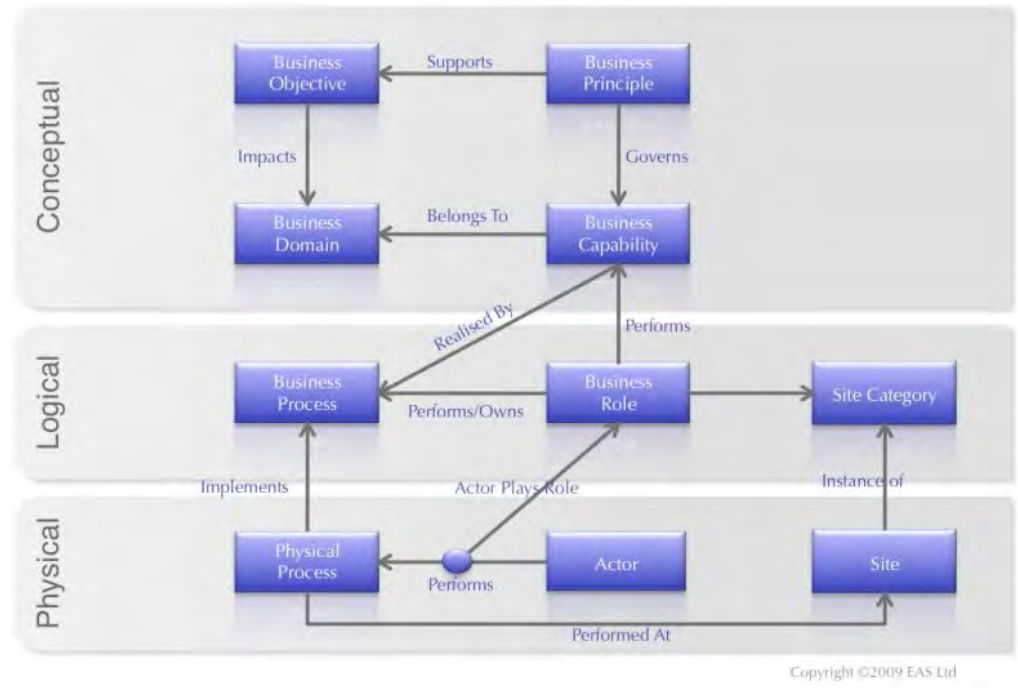


Figure 33: Business Layer of the Essential Meta Model

The ten elements are defined by Essential as:

1. Business Principle: High level rules that govern the manner in which business capabilities are delivered by the enterprise and provide the context for designing and defining how these capabilities will be realised.
2. Business Objective: A strategic business goal for an enterprise.
3. Business Domain: The main groupings of the business, not necessarily the organisational functions.
4. Business Capability: Capabilities represent what the business does (or needs to do) in order to fulfil its objectives and responsibilities.
5. Business Process: A specification or design of how a process should be performed.
6. Business Role: Individual and Group Business Roles, used to represent the design of the organisation in terms of the roles that are required and how they are related.
7. Site Category: A type of location where business processes are performed.
8. Physical Process: The Physical process is an instance of a process (defined in the Logical view) performed by a group or individual, playing a particular Role.

9. Actor: Either an Individual Actor or a Group Actor. It may be a specific, named group, team or individual that performs a role to execute a physical process. An actor can perform more than one business role.
10. Site: Specific, named physical location where processes or activities take place.

The next paragraphs describe the Business Architecture for the four organisations hosting the Waternomics pilots using the Essential Meta Model Business Layer. This provides insights in how the applications can help these organisations reaching current and future strategic goals.

7.1 Business architecture Linate, Milan, Italy

Milano Linate airport was built close to Milan in the 1930's and has had major reconstructions in the 1950's and again in the 1980's. Linate airport is owned by airport operator SEA who also own Malpensa airport, which is located 50 km's from Milan. In 2014, Linate served over a 9 million passengers and shipped nearly 15,000 tonnes of cargo.

Conceptual View of Linate pilot

The mission statement of SEA is "Create value for shareholders, customers and employees". This, rather generic statement, is elucidated by the following statement: "Offering of services and solutions to meet the growing demands of a market comprising multiple entities including passengers, airlines, airport operators and commercial partners." Key element is the recognition of a variety of stakeholders that need to be served and whose, sometimes conflicting, interests need to be managed carefully. The values underpinning the mission statement are compliancy with law and regulation and considering ethics in business as a tool for growth, value creation and creating market confidence.

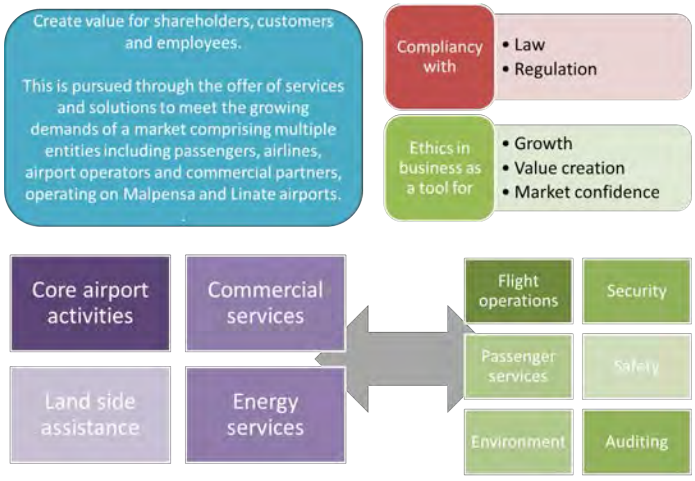


Figure 34: Conceptual view of the Business Layer of Linate

The Business Domain is aviation, split into core airport services, commercial services, land side assistance and energy services. Business Capabilities required to operate successfully in these Business Domains are: flight operations, security, safety-in the air as well as on the ground, passenger services, environment and auditing of handlers. Together, mission, business principles, business domains and capabilities form the Conceptual View of the Business Layer for Linate.

Logical View of Linate pilot

Eight different Business Roles can be defined for Linate:

1. Terminal staff: Group of roles who are responsible for delivering passenger services.
2. Maintenance staff: Group of roles who is responsible for maintenance of the airport infrastructure.

3. Airport management: Assembly of board, principal and middle management responsible for strategic management and daily management of the airport.
4. Security: The collection of security personnel, e.g. border police, responsible for airport security.
5. Safety: Collection of safety officers, traffic control and fire brigade responsible for the safety on the airport.
6. Environment: Environmental officer responsible for airport compliancy with regulation related to the level and impact to air, water and soil pollution and ground based noise.
7. Marketing: Group of roles who is responsible for marketing activities and communication towards stakeholders
8. Sales: Group of roles who is responsible for attracting carriers and passengers to the airport

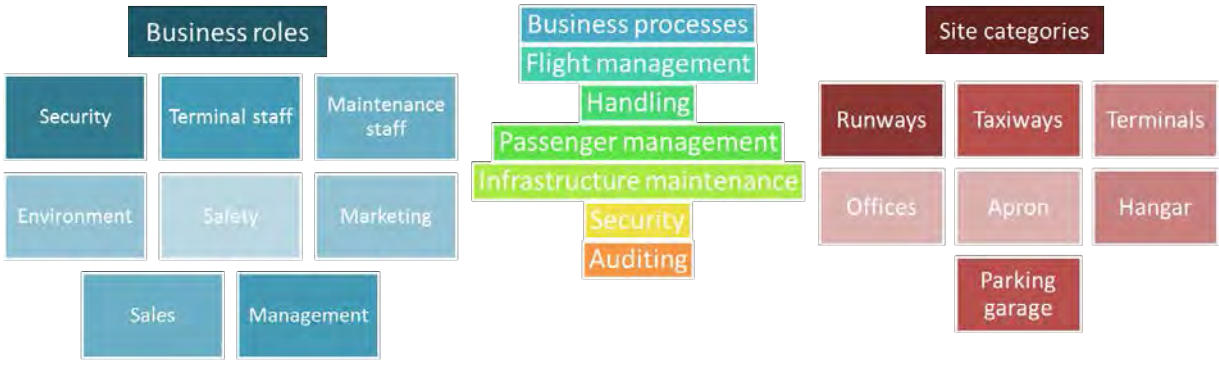


Figure 35: Logical view of Business Layer of Linate?

The high level Business Processes performed at Linate are:

- Flight management
- Handling
- Passenger management
- Maintenance of infrastructure
- Security
- Auditing of all airport activities

Linate requires different types of locations, Site Categories, for performing their business processes and activities. Aircrafts need runways, taxiways and apron to manoeuvre. Passengers need terminals and parking garages for their travel and airport staff needs offices and hangars to do their work.

Together, Business Roles, Business Processes and Site Categories form the logical view of the Business Layer of Linate.

Figure 36: Physical view of the Business Layer of Linate

Physical View of Linate pilot

The four main Physical Processes at Linate related to the Waternomics pilot are:

1. Building management.

2. Safety, anti-fire, de-icing.
3. Environment.
4. Passenger services.

The physical infrastructure of Linate consists of the runways (a main one and a minor/"touristic" one), taxiways, apron, hangar, terminals, office buildings, parking garages and other buildings, electricity grid and lighting, water- and telecommunications-network, ecological platform, roads for vehicle traffic, de-icing plant and a centralized passengers transport system. The main runway has a length of 2442 meter, adequate for larger aircraft including widebodies, but not suitable for larger intercontinental flights with aircraft who require a 3000 meter or longer runway. Linate has undergone major reconstruction twice in the past decades, resulting in different maturity levels for infrastructure across the different sections of the airport.

Users of the airport are:

- Passengers.
- Service providers.
- Staff.
- Management.

Physical processes, actors and site together form the Physical View of the Business Layer of Linate with respect to the Waternomics pilot, as shown in Figure 36.

Business value of Waternomics applications for Linate airport

The Waternomics applications developed for the Linate pilot are listed in the table below.

Table 5: Waternomics applications for the Linate pilot

ID	Name	Target users
LIN.1	Manager's Dashboard	Environmental Manager
LIN.2	Notifications Control Panel	Environmental Manager
LIN.3	Technician's Dashboard	Maintenance staff
LIN.4	Public Displays	Passengers
LIN.5	Observatories Control Panel	Maintenance staff
LIN.6	Social Feedback and News Aggregator	Environmental Manager
LIN.7	Water Savings Calculator Game	Staff, Passengers
LIN.8	Drought Conditions	Environmental Manager
LIN.9	Leak and Fault Detection	Maintenance staff

When plotting the Waternomics applications on the business model of Linate, it shows that the applications create value in three ways:

1. For management, by reducing water and energy usage through increased awareness amongst staff, partners and passengers (LIN.4, LIN.6, LIN.7, LIN.8, LIN.9)

2. For maintenance staff and management, by improved control over the water distribution network and better planning of maintenance activities (LIN.1, LIN.2, LIN.3, LIN.5, LIN.9)
3. For passengers, by Linate showing responsible corporate citizenship, customer relationship is strengthened (LIN.4, LIN.7)

In short, the Waternomics applications contribute to a more efficient operation of Linate airport and a stronger relation with one of the customer segments, the passengers.

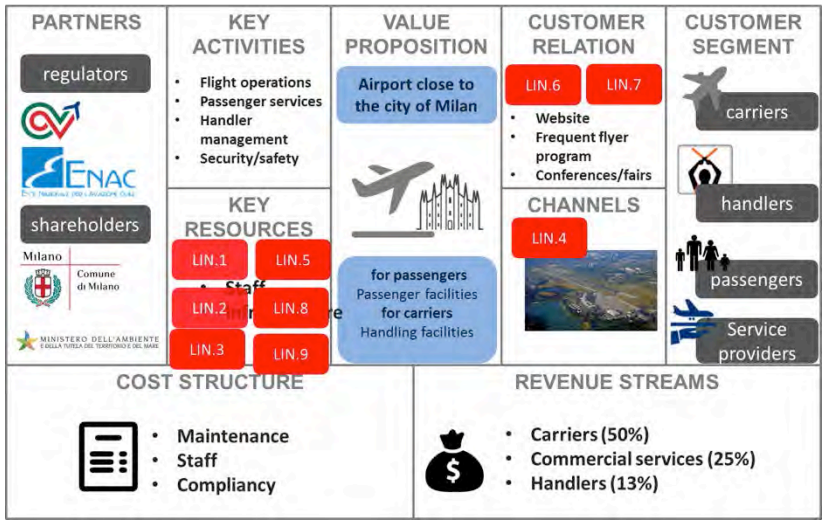


Figure 37: Business model of Linate with Waternomics applications

7.2 Business architecture Thermi, Greece

The municipality of Thermi is located near the city of Thessaloniki in the north of Greece. The municipality originated from the 2011 merger of three former municipalities: Mikra, Thermi and Vasilika. The municipality of Thermi covers an area of 385.321 hectares and has a population of 53.000 inhabitants (2011).

Conceptual View of Thermi pilot

Thermi aims to be a "high quality living area, centre for business infrastructure for the wider Thessaloniki region and an open city with equal opportunities for all".

The underlying values, extracted from Thermi's vision, are: **sustainable** especially the management of environment and resources**, innovative**, **equal**, **modern** with respect to organisation and **high quality** standards.

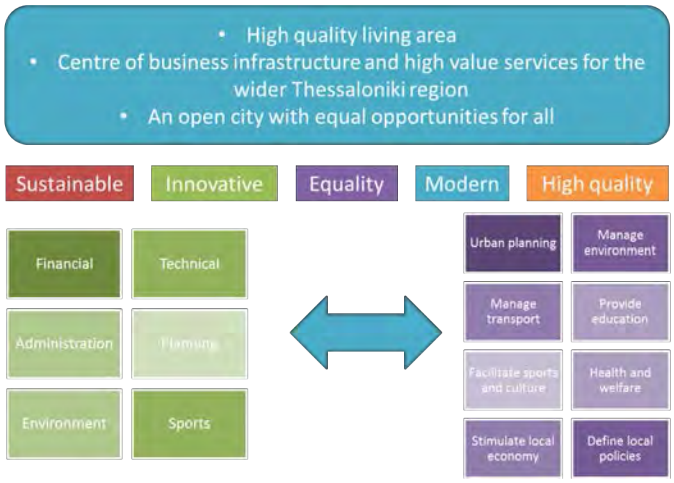


Figure 38: Conceptual view of the Business Layer of Thermi

The Municipality of Thermi provides public services, divided into the following Business Domains: financial, technical, administration, planning, environment, including water and energy, and sports.

Capabilities required to operate successfully in these Business Domains are: urban planning, management of the environment, management of transport, providing educational services, facilitating and stimulating sports and culture, health and welfare, stimulation of local economy and defining local policies. Together, mission, business principles, business domains and capabilities form the conceptual view of the Business Layer for Thermi, as shown in Figure 38.

Logical View of Thermi pilot

Six different Business Roles can be defined for Thermi:

1. Municipal staff: Group of roles responsible for governance and management of Thermi, including Office of the Mayor, Vice Mayor, General Secretary and councillors.
2. Administration: Group of roles who is responsible for the performance of administrative tasks of the municipality.
3. Local business: Locally owned businesses serving the local population and the wider Thessaloniki region.
4. Citizens: All inhabitants of Thermi.
5. Thermi agencies: Collection of legal entities, responsible for a specific public task. E.g. D.E.Y.A. is the public water and sewage utility.
6. Visitors: Group of roles spanning non-residents visiting the Thermi region for business or pleasure.

The high level Business Processes performed at Thermi are:

- Urban planning
- Waste management
- Social welfare services
- Education services
- Infrastructure management
- Public services

Thermi gives home to five different types of locations, Site Categories, within the area of their jurisdiction. These site categories are:

1. Office: offices for administrative staff and city council
2. Basic Infrastructure: transport infrastructure including roads, public transport and parking places, and environmental infrastructure including water, sewage and irrigation network,
3. Public building: City hall, school, library, police office
4. Sport facility: Sports centre, soccer fields, basketball courts, soccer stadium,
5. Archaeological site: Diverse ancient buildings, technical works and locations like the remains of prehistoric settlements, Church of St Nicholas, water supply pipeline from Chortiatis or multiple Byzantine monuments.

Together, Business Roles, Business Processes and Site Categories form the logical view of the Business Layer of Thermi.

Figure 39: Logical view of Business Layer of Thermi

Physical View of Thermi pilot

The four main physical processes at Thermi related to the Waternomics pilot are:

1. Provide drinking water services
2. Manage drinking water resources
3. Provide primary and secondary education
4. Manage public buildings

Figure 40: Physical view of Thermi Business Layer

The basic source of surface water is the Anthemountas river. Some communities are served by small water reservoirs created with dams, like the Triadi reservoir (18 hectares). The main source of drinking water is ground water which is pumped up by multiple wells. Due to growth in water demand from industry and irrigation, Thermi has a negative water balance since the 1970's. Differences in level of maturity of the water distribution networks from the former municipalities Mikra, Thermi and Vasilika, hinder proper integration of the networks.

The main actors in Thermi with respect to drinking water are:

- Environmental manager of the municipality of Thermi
- D.E.Y.A staff
- Citizens
- Local businesses

Physical processes, actors and site together form the physical view of the Business Layer of Thermi with respect to the Waternomics pilot.

Business value of Waternomics applications for Thermi

The Waternomics applications developed for the Thermi pilot are listed in the table below.

Table 6: Waternomics applications for the Thermi pilot

ID	Name	Target users in the household
THE.1	Family Dashboard	Adults
THE.2	Water Consumption Timeline	Everyone
THE.3	Notifications Panel	Everyone
THE.4	Leaderboards	Adults
THE.5	Observatories Control Panel	Everyone
THE.6	Social Feedback and News Aggregator	Everyone
THE.7	Water Savings Calculator Game	Everyone
THE.8	Drought Conditions	Everyone

When plotting the applications on the business model of Thermi, it shows that the applications create value in three ways:

1. For citizens, by reducing their water usage through increased awareness amongst all family members (All applications)
2. For municipal staff, by reducing demand on scarce water resources and introducing new channels to engage citizens(THE.8, THE.9)
3. For D.E.Y.A. staff, by reducing the number of disputes over the water bill by introducing real time metering (THE.2).

In short, the Waternomics applications contribute to an increased awareness of water consumption and water availability amongst the citizens of the municipality of Thermi. As a result, it can be expected that domestic water usage will decrease and Thermi will strengthen its image as a modern and sustainable municipality.

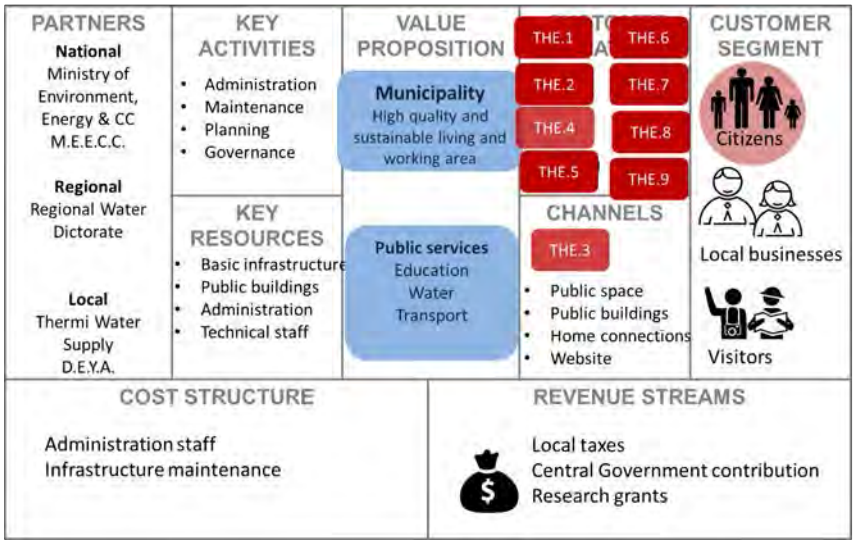


Figure 41: Business model of Thermi with Waternomics applications

7.3 Business Architecture National University of Galway, Ireland

First established in 1849, NUI Galway is internationally recognized as a research-led university with a commitment to top-quality teaching. NUI Galway currently accommodates approximately 17,000 students and 2,200 staff. The university's campus is located in the city of Galway on the West Coast of Ireland and has over 90 buildings on 105 hectares of land.

Conceptual View of NUI Galway pilot

The Business Objective can be best described by the mission and vision of NUI Galway. The mission of NUI Galway is "to foster a vibrant community of students and staff, where distinguished learning, impactful research, and creative thinking are shared with the world." The vision of NUI Galway is: "NUI Galway aims to be a leading global university, renowned for their distinctive areas of research, recognised as an institution of choice for teaching and scholarship, celebrated for their outstanding engagement with wider society, and enriched by a dynamic network of partnerships."

The activities and work of NUI Galway are underpinned by five core values or Business Principles as described in the Strategic Plan, being:

1. **Ambition** – we share a drive for excellence and leadership, working to a common purpose with confidence in our mission
2. **Creativity** – inspired by our unique location, a distinctive spirit of creativity imbues everything we do

3. **Impact** – our engagement and actions will make a meaningful difference in Galway, across the country, and around the world
4. **Collaboration** – strong, mutually-beneficial partnerships are at the heart of our approach, as we engage locally and internationally
5. **Integrity** – building on our rich heritage, we value openness, diversity and good citizenship

The Business Domains interlinked with the Waternomics applications are Operations / Maintenance and Research. Key activities for NUI Galway are Teaching, Research, Recruitment, Maintenance and Procurement.

Together, mission & vision, business principles, business domains and capabilities, form the conceptual view of the Business Layer for NUI Galway, as shown in Figure 42.

Figure 42: Conceptual view of Business Layer NUI Galway

Logical View of NUI Galway pilot

Business Roles represent the design of the University in terms of roles required to perform the processes. Five different roles related to water can be distinguished:

- Colleges: - responsible for the teaching and courses of a specific discipline, e.g. Arts, Medicine or Engineering.
- Research Office: - responsible for the execution of research in the selected areas and with selected partners.
- Technology Transfer Office (TTO): - Supports, promotes and facilitates the transfer of research to commerce.
- Buildings Office: - responsible for the maintenance of the campus and all its buildings.
- Finance: A group of roles responsible for the administration of college activities including all financial processes. The Business Processes performed at NUI Galway are:
- Conduct research
- Teach courses
- Recruit students
- Maintain campus
- Find partnerships

NUI Galway requires different types of locations, Site Categories, for performing their business processes and activities. Their colleges and schools require teaching facilities where teachers can teach their courses, research laboratories for the different research areas and offices for supporting departments.

Business Roles, Business Processes and Site Categories together form the logical view of the Business Layer.

Figure 43: Logical view of Business Layer NUI Galway

Physical View of NUI Galway pilot

As described in Chapter 6, all Waternomics applications for the NUI Galway pilot will be deployed in the NUI Galway Engineering Building (NEB). Therefore, the Physical View focusses solely on NEB, it's users and the activities conducted in NEB.

The Engineering Building features a Building Management System (BMS) that controls and monitors the mechanical and electrical equipment at the building such as ventilation, water and power systems

Water usage at the Engineering Building is monitored by 14 fixed inline water meters and 8 pipe mounted USF water meters. 3 of the inline meters and all of the USF meters were installed as part of the Waternomics Project. The building is equipped with a rain water harvesting system and a domestic hot water system which interacts with the installed solar panels.

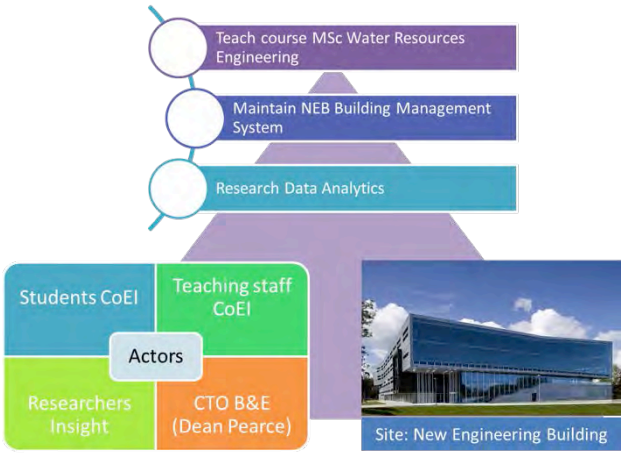


Figure 44: Physical view of Business Layer NUI Galway

The Buildings Office of NUIG is responsible for management and maintenance of the NEB. Works are requested by the Chief Technical Officer (if required) and carried out by Buildings Office employees or external sub-contractors if specialists are required. In 2013, NUI Galway achieved International Energy Standard ISO 5001.

Buildings Office also initiated the Green Campus programme. This programme assists in reducing our overall costs and associated carbon emissions and reinforce the message of energy minimisation to all staff and students.

Actors consist of users of the building, being:

- Staff and students from the college of Engineering and Informatice (CoEI).
- Friars restaurant is renting building space for the exploitation of the in-house café named ZINC.

The three main Physical Processes related to the Waternomics applications are:

1. Providing courses like MSc Water Resources Engineering, MoE Civil Engineering, MoE, Energy Systems or MSc Software Design and Database Technologies.

2. NEB building management
3. Research on water and data analytics as conducted in research programs like Environmental Engineering or in research groups like Informatics Research Unit for Sustainable Engineering (IRUSE) who is committed to realising the goal of energy efficient buildings, the Ryan Institute, NUIG's hub for Environmental, Marine and Energy research, the Insight Centre for Data Analytics, NUIG's Sustainable Engineering Research or NUIG's Psychology Research.

Physical processes, Actors and Site, together form the Physical View of the Business Layer of NUI Galway with respect to the Waternomics pilot.

Business value of Waternomics applications for NUI Galway

When plotting all available business information on a business model canvas, the business model of NUI Galway looks like the figure below.

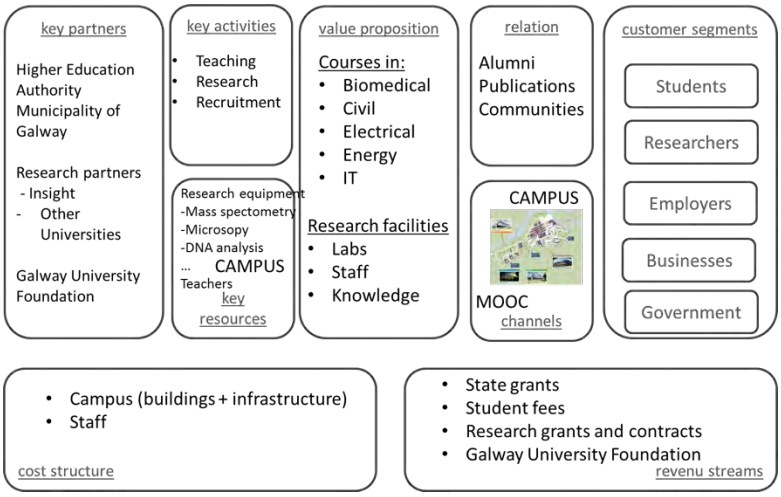


Figure 45: Business model of NUI Galway

The Waternomics applications developed for the NUI Galway pilot are show in Table 7.

Table 7: Waternomics applications for the NUI Galway pilot

ID	Name	Target users
NEB.1	Goal-Oriented Accessing Water	Students / Staff
NEB.2	Physical Consumption Feedback	Students / Staff
NEB.3	Public display	Students / Staff
NEB.4	Manager's Dashboard	Building Manager
NEB.5	Control Dashboard	Building Manager
NEB.6	Water retention time observer	Building Manager
NEB.7	Wearable Infocentre	Building Manager
NEB.8	Observatories Control Panel	Building Manager
NEB.9	Social Feedback and News Aggregator	Students / Staff

NEB.10	Water Savings Calculator Game	Students / Staff
NEB.11	Drought Conditions	Students / Staff
NEB.12	Leak and Fault Detection	Building Manager

First, the Waternomics applications are plotted on the current business model of NUI Galway to see how and where the Waternomics applications add value.

NEB.4, NEB.5, NEB.6, NEB.7, NEB.8 & NEB.12 can be considered as an extension of the BMS. With these applications, building management gets a more detailed insight in water consumption and expected water availability.

NEB.2, NEB.3 and NEB.9 are new channels on which water related information is published to the staff and students.

NEB.1, NEB.10 and NEB.11 are mechanisms to improve the relationship with the students at NUI Galway.

From the resulting canvas it shows that the Waternomics applications do not result in entirely new value propositions for the University but rather improve or enforce the existing business model. The applications create value in three ways for NUI Galway:

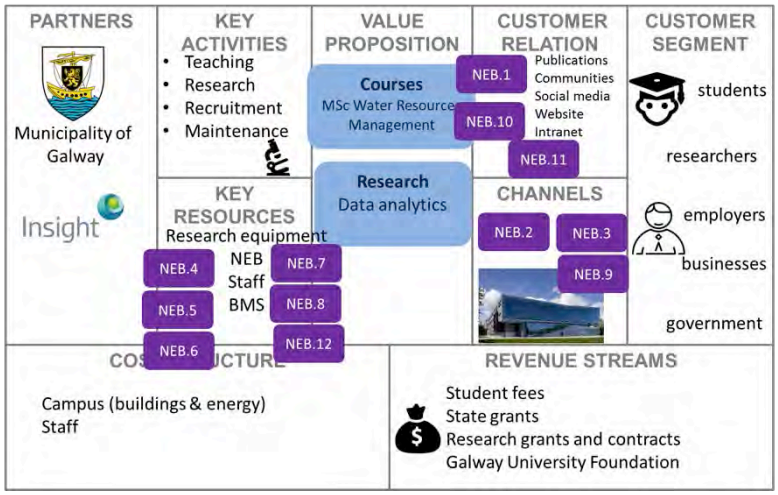


Figure 46: Applications mapped on NUIG canvas

1. For management, by reducing water and energy usage through increased awareness amongst staff and students (NEB.1, NEB.2, NEB.5, NEB.6, NEB.8, NEB.10, NEB.11 & NEB.12)
2. For maintenance staff, by expanding the building management system with detailed water distribution and consumption information (NEB.3, NEB.4 & NEB.9)
3. For teaching staff, by enriching the teaching material with local water information (NEB.7)

This is in line with the Universities ambition to provide an inspiring learning environment, show good citizenship and engage with wider society. Note that value is also created for research partners such as Insight by generation real time water consumption data. This is not visible in the diagram because there is no separate application for providing access to water consumption data for third parties.

7.4 Business architecture Colaiste na Coirbe, Galway, Ireland

On 1st September 1992, Coláiste na Coiribe (CnaC) opened its doors at the first all-Irish secondary school in Galway City. CnaC attracts students from all over Ireland. There are currently approximately 350 students in the school. Currently, a new facility is being constructed which can house up to 720 students. The new facility is due to be opened beginning of 2016.

Conceptual View of CnaC pilot

The mission statement of CnaC is:

"Coláiste na Coiribe will provide a high standard of education through the medium of Irish, promoting Irish culture. Our aim is to promote all aspects of a student's development: spiritual, moral, intellectual, physical, aesthetic, and emotional." The various elements of student development, together with the solitary use of the Irish language, can be considered as the business principles of CnaC.

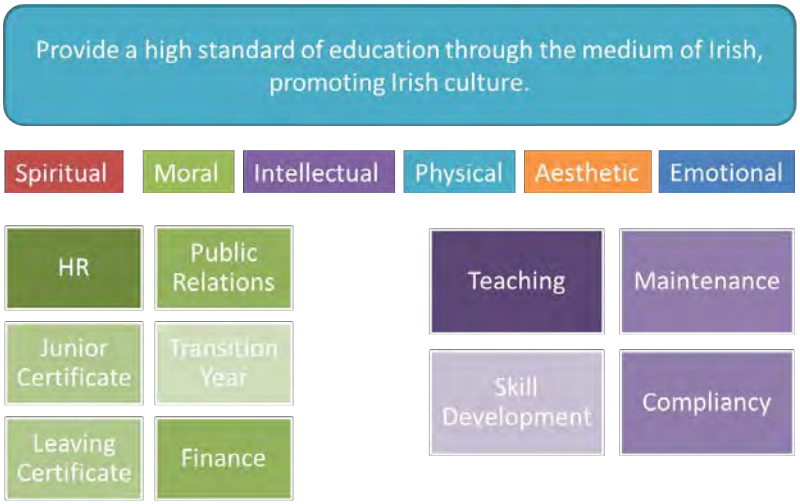


Figure 47: Conceptual view of the Business Layer of CnaC

The Business Domain is education, split into human resource management (HR), public relations, finance and the teaching of the four courses. Business Capabilities required to operate successfully in these Business Domains are: Teaching, building maintenance, skill development and compliancy. Together, mission, business principles, Business Domains and Business Capabilities form the conceptual view of the Business Layer for CnaC, as shown in Figure 47

Logical View of CnaC pilot

Five different Business Roles can be defined for CnaC:

1. Teaching staff: Group of roles who are responsible for the teaching and courses of a specific discipline.
2. Support staff: Group of roles who is responsible for execution of supporting processes like building maintenance, finance, HR and communication.
3. School management: Assembly of board, principal and middle management responsible for strategic management and daily management of the school.
4. Students: The collection of students from the various courses.
5. Parents: The parents from the students.

The Business Processes performed at CnaC are:

- Teach courses
- Recruit students
- Monitor students
- Maintain accommodation
- Maintain curriculum

CnaC requires different types of locations, Site Categories, for performing their business processes and activities. Their colleges require teaching facilities where teachers can teach their courses, sports facilities for the sports classes, playing pith and canteen for the students and offices for supporting departments.

Together, Business Roles, Business Processes and Site Categories form the logical view of the Business Layer of CnaC.

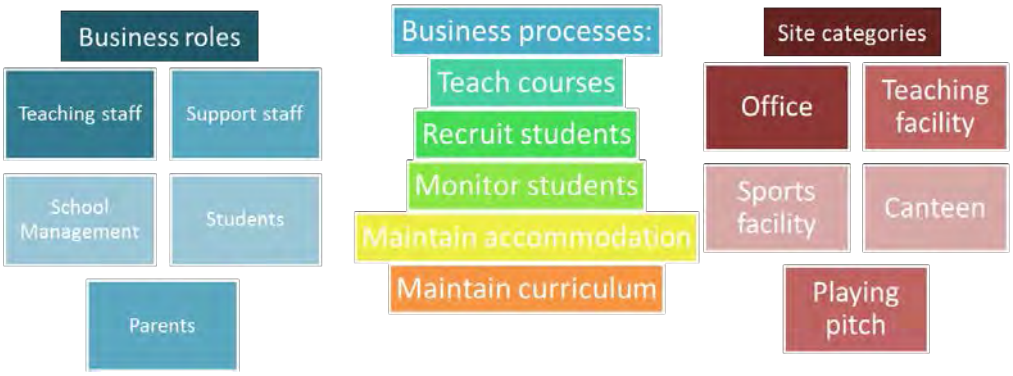


Figure 48: Logical view of Business Layer of CnaC

Physical View of CnaC pilot

The Physical View contains the Physical Processes, the Actors and the Site. The three main Physical Processes are:

1. Teach courses Junior Certificate, Transition Year, Leaving Certificate and LCVP.
2. Monitor and evaluate students
3. Maintain accommodation, including water and energy usage.

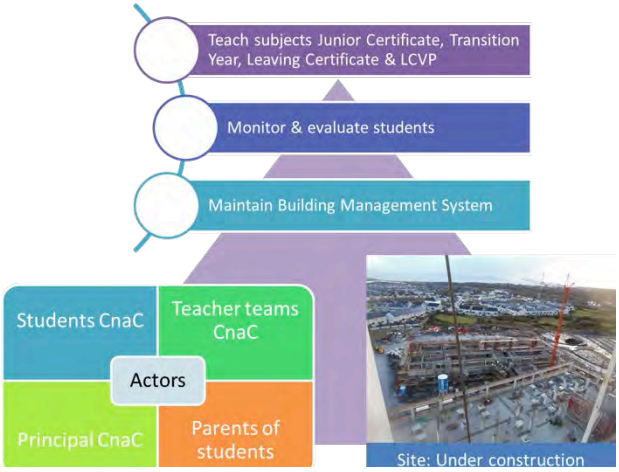


Figure 49: Physical view of CnaC Business Layer

Regarding the Site, CnaC is in the process of moving to a new accommodation. This new facility will have room for 720 students and will have three and two storey teaching blocks, a sports hall and five hard court surfaced ball courts. The building will be equipped with a building management system (BMS). The construction of the new school was finished by the end of 2015.

Users of the building Actors, are:

- CnaC staff and students
- Initially students from local Gaelscoileanna and Gaeltacht schools.
- Visitors, like the parents of the students

Physical processes, Actors and Site together form the Physical View of the Business Layer of CnaC with respect to the Waternomics pilot.

Business value of Waternomics applications for CnaC

The Waternomics applications developed for the CnaC pilot are:

Table 8: Waternomics applications for the CnaC Galway pilot

ID	Name	Target users
CNAC.1	Manager's Dashboard	Building Manager

CNAC.2	Public Display	Students
CNAC.3	Observatories Control Panel	Building Manager
CNAC.4	Social Feedback and News Aggregator	Students / Staff
CNAC.5	Water Savings Calculator Game	Students / Staff
CNAC.6	Drought Conditions	Students / Staff
CNAC.7	Leak and Fault Detection	Building Manager

When plotting the applications on the business model of CnaC, it shows that the Waternomics applications create value in three ways:

1. For management, by reducing water and energy usage through increased awareness amongst staff and students (CNAC.2, CNAC.4, CNAC.5)
2. For maintenance staff, by expanding the building management system with detailed water distribution and consumption information (CNAC.1, CNAC.3, CNAC.7)
3. For teaching staff, by enriching the teaching material with local water information (CNAC.5, CNAC.6)

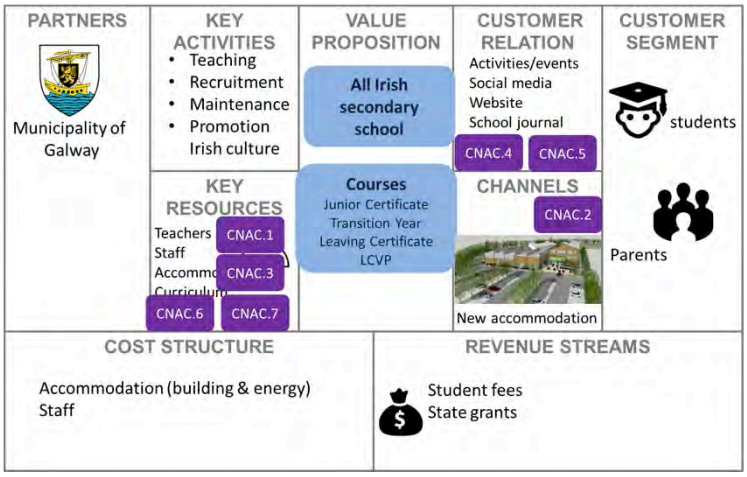


Figure 50: Business model of CnaC with Waternomics applications

8 Conclusions

This deliverable, presented a set of applications developed for the different pilot sites in the Waternomics project. The complexity of the problem was made clear quite early in the design phase of applications where although common needs were identified between pilot sites and user groups there was no easy way to meet them all together for all users. Even within those common needs we identified different preferences and approaches from each user that made the problem solving quite difficult.

That is why we followed an approach that can combine both meeting common needs while also allowing much room for personalization to specific details and preferences of different users. The main concept for the approach is the WApP that takes care of fundamental development issues such as user management and notifications handling and allows developers to focus on providing applications for specific micro-problems highly personalized and tailored to specific user needs and requirements. Moreover, the WApP also provides users with the app configuration tool and components to build their own applications by combining and configuring different components developed to meet basic needs. Personalization is also part of this building process as the components used are automatically adjusted for them based on already identified preferences.

In the following sections we are highlighting some key aspects in the deliverable that summarize the innovative ideas and concepts introduced by applications in the Waternomics project.

8.1 Highlight #1: The Waternomics Applications Platform (WApP)

The WApP itself is one of the major innovations in Waternomics. WApP transfers the paradigm of applications market place that has been successfully used in other domains in the water related applications domain. Combined with the Waternomics Information Platform enable the creation of an ecosystem of applications around water consumption, conservation and awareness that allows third party developers of applications to easily integrate and explore its potentials. The benefits of WApP have been extensively presented in chapter 2 and we can conclude that it is the enabling factor in answering to a wide variety of users with different needs and different profiles. With such a variety it is difficult to have a one size fits all solution if it doesn't allow users the appropriate control, guidance and freedom and WApP succeeds in exactly this.

The WApP provided the solution to this complex problem by allowing the creation of 20 applications targeting 19 different user groups in the 4 pilot sites that are being presented in this deliverable. However, due to some applications that are actually families of applications the actual individual application instances deployed for all pilot sites exceeds 20. Actually the number of individual applications deployed is quite dynamic since the same application can be deployed multiple times for different user groups or even for the same user based on his/her individual needs. In total, the applications presented can be categorized to the following:

- 5 cross pilot applications that will be used in all pilots.
- 4 pilot specific applications for the pilot in Linate airport
- 4 pilot specific applications for the pilot in Thermi
- 6 pilot specific applications for the two different pilot sites in Galway

Between them there are applications for getting information about water consumption (e.g. the family and the manager's dashboards), getting notifications when specific events happen (notifications panel for domestic users and the wearable info-centre for building managers), tracking operations' progress based on related actions (e.g. notifications control panel for

managers in Linate and NEB), discovering and reading news (e.g. news and social feedback aggregator) and other related educational content and playing (e.g. Water savings calculator game for all pilots).

The concept and infrastructure of WApP together with the number of different applications deployed in all pilot sites enables the creation of an ecosystem of applications that meet all needs and requirements identified in earlier deliverables through personalized information delivery and encouragement of social interaction and collaboration to raise awareness for water consumption. Finally, it creates the necessary room and facilities for integration of additional external applications being developed by other projects and third party developers aiming to inform user about water consumption issues.

8.2 Highlight #2: More than notifications

Notifications are an essential part of many kinds of applications platforms (Acharya, 2016) and are also an essential part of the WApP. However, emerging technologies and practices in user experience show that notifications will probably play a much more significant role in similar ecosystems in the future. Actually many of modern application ecosystems use notifications as a main point of entry for many applications. The second trend identified is also the contextuallitity of notifications. We are living in a world of information overload so getting the precisely right and appropriate type of notification at the time we need it and in the way we need it is essential. The Waternomics Information Platform together with the API for handling notification in the WApP enables this contextuallity for appellations that want to attract users' attention only when necessary and not annoy them. Finally, notifications in WApP are also following another trend in the area. They allow for taking actions from within the notification itself and actually call the users to take specific actions in order to get rid of them. The system can then use users behaviour on notifications to provide the user with meaningful statistics (such as in the case of the airport) or encouragement and rewarding messages (such as in the end of domestic users). The notifications of WApP have also a unique feature of enabling crowdsourcing actions to be taken collectively by a targeted user group through the shared notifications feature (ul Hassan 2013).

8.3 Highlight #3: A touch of UX everywhere

UX is a crucial aspect of the WApP trying to follow the latest trend trends and developments in the area (Teixeira, 2016). Apart from providing the necessary flexibility and customization options Waternomics applications make an effort in connecting with users emotions though meaningful, pleasant and memorable micro-experiences introduced in many different parts of the applications. From the variety of water flavours used to display the users consumption in their dashboards, to pleasant, funny and surprising messages based on user profiles when users act on their notifications, or achieve a goal in the observatories set-up or even in their home application, users will continuously find rewarding moments of interaction to engage them more in the applications, attract their attention and stick to their minds. Through, such surprising and unexpected ways of response the applications aim to communicate to users key messages that will help in changing their way of thinking around water consumption and in long term affect their behaviour.

8.4 Highlight #4: Same application but actually different

The cross-pilot applications are another example of how the WApP enables personalization amongst it's applications. Although each application has the same functionality in all cases the

actual application seen by each user differs. For example the news and social media content presented in the respective application will not display the same news to managers and domestic users alike. It will also filter news items based on pilot so that it displays only relevant information to each user. Therefore, although all users are faced with the same application a number of parameters play a role in changing the UI and content based on the users' profile. This adaptation takes place without the user's participation and aims to personalize the experience of different users using the same applications. A similar kind of personalization happens also within specific components so that they appear or show different information based on the user and a number of already known preferences they have. Therefore, although users seem to use the same application it feels and responds differently in each case making it more personal.

8.5 Highlight #5: Common objectives, many different paths

Finally, the most important outcome to highlight from this deliverable comes in combination with the objectives of different pilots described in D5.1. As understood from D5.1 most of the objectives are common among pilots such as raising awareness, reducing water consumption etc. However, in each case the objective can be reached through different paths depending on the users profile and environment. The different applications described in this deliverable are all aiming at these objectives but by providing different experiences the applications are employing different techniques to achieve them in different contexts. Therefore, the most important message that can come out of this deliverable is that in the Waternomics project we are trying to achieve a mostly common set of objectives using different paths through a number of different applications.

Appendix 1: Waternomics applications in relation with requirements of D1.3

KPI / Objective / User group		Pilot specific applications				Cross pilot applications				
		Manager's dashboard	Notifications control panel	Technicians dashboard	Public display	Observatories control panel	Social and news aggregator	Water savings calculator game	Drought conditions monitoring	Leak and fault detection
D1.3 KPIs	Incoming / outgoing water & wastewater volumes	X			X					
	Comparison of consumption with past periods (reduction or increase)	X				X				
	Comparison of consumption with future targets	X				X				
	Comparison of consumption between different sections / sensors (difference)	X			X	X				X
	Simulation of new pricing policies with seasonal variations	X								
	Simulation of new infrastructure effects							X		X
	Benchmarking new infrastructure effects	X		X		X				
	Detection of leakages / faults		X	X						
	Estimation of leakage / faults costs	X	X	X						
	Benchmarking of repairs	X		X						

KPI / Objective / User group		Pilot specific applications				Cross pilot applications				
		Family dashboard	Water consumption timeline	Notification panel	Leaderboards	Observatories control panel	Social and news aggregator	Water savings calculator game	Drought conditions monitoring	Leak and fault detection
D1.3 KPIs	Benchmarking / Water Footprints	X	X		X	X		X		
	Budgeting / Forecasting / Planning	X		X		X				X
	Consumption / Quantity / Volume	X	X	X	X	X				
	Comparison of consumption between different sections / sensors (difference)	X	X	X	X	X				
	Data Access				X		X			
	Economics / Costs	X						X		
	Energy	X						X		
	Environment	X			X		X	X		
	Leaks / Faults			X						X
	Water Quality			X			X			
	Water Awareness	X	X		X	X	X	X	X	

KPI / Objective / User group		Pilot specific applications						Cross pilot applications				
		Goal-oriented accessing water	Public display	Manager's dashboard	Physical Consumption feedback	Water retention time observer	Wearable info centre	Observatories control panel	Social and news aggregator	Water savings calculator game	Drought conditions monitoring	Leak and fault detection
D1.3 KPIs	Retention time					X	X					
	Data access events			X								
	Benchmarking / Water Footprints		X	X				X		X		
	Budgeting / Forecasting / Planning			X				X				X
	Consumption / Quantity / Volume	X	X	X	X			X				
	Data Access			X								
	Economics / Costs		X	X						X		
	Energy		X	X						X		
	Environment		X	X					X	X		
	Infrastructure						X	X				
	Fault detection						X					X
	Water Quality					X			X			
	Water Awareness	X	X	X	X			X	X	X	X	

Appendix 2: Notifications API

API will include the following URLs.

insertNotification

The URL for inserting notification with values marked with yes in API column. This will be done through a Post request with a JSON with the appropriate values. It will return the new NotificationId

URL: http://services.ultra4.eu/waternomics/notification/insertNotification.ac

Method: POST

Content-Type: application/x-www-form-urlencoded

Parameters in JSON format:

Name	Required	Type	Description
appId	Yes	Number	The id of the application that creates the notification (will be provided by U4 for external apps)
userId	Yes. **ONLY ONE** of the **MUST** be provided	Number	The userID of the targeted user if the notification is for one specific user. **Note:** Applications will know userID who is logged in from the Waternomics apps platform.
groupId		Number	The groupId which the notification is targeting. **Note:** Group names and ids should be provided to applications by the dataspace through an appropriate service
shared	Yes only if GroupId is provided	Boolean	If Yes then the notification is shared which means that if any member of the group takes the action the notification is marked as acted for all users in the group. If No then each member of the group will receive the notification but handle it individually. So it has to be acted upon by all members separately
sensorId	No	Text	The Id of the sensor the notification is about. If not sent then no sensor will be connected with the notification
title	Yes	Text	Title of the notification
description	Yes	Text	Text of the notification. A more elaborate description than the title
imageURL	No	URL Text	A url for an image assosicated with the notification.

			If no image URL is provided the notification will be displayed with the image of the sensor (from sensorId). If no sensorId is provided then the image of the application that created the notification will be used.
criticality	Yes	Text	The criticality of the notification. Values can be only one of the following (info, low, medium, high).
actionText	No	Text	The text to appear in the action taken button. Default value if no text is provided will be “Action Taken”
actionURL	No	URL Text	The url the user will be redirected if he presses the “Action Taken” button.
snoozeText	No	Text	The text to appear in the snooze button. Default value if no text is provided will be “Remind me later”
snoozeURL	No	URL Text	The url the user will be redirected if he presses the “Remind me later” button.
snoozeTime	No	Time in seconds	The time to snooze the notification if the snooze button is pressed. If no time is provided then the snooze time will be assigned based on criticality level info: 1 week low: 3 days medium: 1 day high: 1 hour
noActionText	No	Text	The text to appear in the snooze button. Default value if no text is provided will be “Ignore it”
noActionURL	No	URL Text	The url the user will be redirected if he presses the “Ignore itr” button.

Example 1:

Example of an individual group notification for consumption reaching the monthly goal of a group. Group 402 is the technicians group. Each user in the technicians group can handle (press action buttons) the notification individually as he likes. Notification is marked as acted, dismissed or snoozed for each user individually.

```
notification={
    "applicationId": "1000232",
    "groupId": "402",
    "sensorId": "MS1",
    "title": "Consumption reaching monthly goal",
    "description": "Your consumption in sensor MS1 is over 90% of the goal you had set up. Be careful!",
    "imageURL": "http://www.example.com/water/floodingimage.jpg",
```

```
    "criticality": "low",
    "actionText": "OK. I'll be carefull",
    "snoozeText": "Remind me in 2 days",
    "snoozeTime": "172800000",
    "noActionText": "Ignore it"
}
Returns:

{

"Id" : "1230455",
"state":"created"
}
```

Example 2:

Example of a shared group notification for inactivity in one meter. Group 404 is students. If one student presses the "Action taken" button (showing "OK. I opened it for 10 minutes") the notification is marked as acted and not shown to the rest of the students.

```
notification={
    "applicationId": "1000332",
    "groupId": "404",
    "sensorId": "MS.CWS1",
    "title": "Water retention period too long",
    "description": "No water activity in the pipe metered by MS.CWS1 sensor in ground floor water fountain has been registered for the last week. Please open the fountain for 10 minutes!",
    "criticality": "high",
    "actionText": "OK. I opened it for 10 minutes",
    "snoozeText": "Remind me later",
    "noActionText": "Ignore it"
}
```

actionTaken

The URL for marking the taking of an action on a notification. This will be done through a Post request with a JSON that will include:

URL: http://services.ultra4.eu/waternomics/notification/actionTaken.ac

Method: POST

Content-Type: application/x-www-form-urlencoded

Parameters in JSON format:

Name	Required	Type	Description
Id	Yes	Number	The id of the notification to be marked as acted
userId	Yes	Number	The userId of the user who took the action

Example 1:

POST to http://services.ultra4.eu/waternomics/notification/actionTaken.ac

notification={
"Id": "1000112",
"userId": "402"
}
Returns

{
“Id”:”1000112”,
“state”:”acted”
}

snooze

The URL for marking the snoozing of a notification. This will be done through a Post request with a JSON that will include

URL: http://services.ultra4.eu/waternomics/notification/snooze.ac

Method: POST

Content-Type: application/x-www-form-urlencoded

Parameters in JSON format:

Name	Required	Type	Description
Id	Yes	Number	The id of the notification to be marked as acted
userId	Yes	Number	The userId of the user who took the action
snoozeTime	No	Time in seconds	The time to snooze the notification. If not provided the default value will be used (see insertNotification)

Example 1:

POST to http://services.ultra4.eu/waternomics/notification/snooze.ac

notification={
"Id": "1000112",
"userId": "402",
“snoozeTime”: 360
}
Returns

{
“Id”:”1000112”,
“state”:”snoozed”,
timeToSend:”17/11/2015 14:15:00”
}

dismiss

The URL for marking the dismissal of a notification. This will be done through a Post request with a JSON that will include

URL: http://services.ultra4.eu/waternomics/notification/dismiss.ac

Method: POST

Content-Type: application/x-www-form-urlencoded

Parameters in JSON format:

Name	Required	Type	Description
Id	Yes	Number	The id of the notification to be marked as acted
userId	Yes	Number	The userId of the user who took the action

Example 1:

POST to http://services.ultra4.eu/waternomics/notification/dismiss.ac

```
notification={
    "Id": "1000112",
    "userId": "402",
}
```

Returns

```
{
“Id”:”1000112”,
“state”:”dismissed”
}
```

listNotificaions

The URL to get notifications based on the following fields as criteria. Using multiple parameters will act as AND between criteria.

URL: http://services.ultra4.eu/waternomics/notification/listNotifications.ac

Method: POST

Content-Type: application/x-www-form-urlencoded

Parameters in JSON format:

Name	Required	Type	Description
appId	No	Number	The id of the application that creates the notification (will be provided by U4 for external apps)
userId	No. **ONLY ONE** of the can be provided	Number	The userID of the targeted user if the notification is for one specific user. **Note:** Applications will know userID who is logged in from the Waternomics apps platform.
groupId		Number	The groupId which the notification is targeting.

			Note: Group names and ids should be provided to applications by the dataspace through an appropriate service
shared	No	Boolean	If Yes then the notification is shared which means that if any member of the group takes the action the notification is marked as acted for all users in the group. If No then each member of the group will receive the notification but handle it individually. So it has to be acted upon by all members separately
sensorId	No	Text	The Id of the sensor the notification is about. If not sent then no sensor will be connected with the notification
criticality	No	Text	The criticality of the notification. Values can be only one of the following (info, low, medium, high).
state	No	Text	The text to appear in the action taken button. Default value if no text is provided will be “Action Taken”

Example 1:

POST to http://services.ultra4.eu/waternomics/notification/listNotifications.ac

```
notification={
    "userId": "4021"
}
```

Returns

```
[{
    “Id”:”1000324”,
    "applicationId": "1000232",
    "groupId": "402",
    "sensorId": "MS1",
    "title": "Consumption reaching monthly goal",
    "description": "Your consumption in sensor MS1 is over 90% of the goal you had set up. Be careful!",
    "imageURL": "http://www.example.com/water/floodingimage.jpg",
    "criticality": "low",
    "actionText": "OK. I’ll be carefull",
    "snoozeText": "Remind me in 2 days",
    "snoozeTime": "172800000",
    "noActionText": "Ignore it"
    “log”:[{“action”:”created”.
            “time”:”17/11/2015 10:00:00”
            }
            {“action”:”snoozed”.
            “time”:”17/11/2015 10:10:00”,
            “userId”:”4021”
            },
            {“action”:”acted”.
            “time”:”17/11/2015 11:13:00”,
            “userId”:”4021”
            }]
},
{...},
{...},
...
]
```

Example 2:

POST to http://services.ultra4.eu/waternomics/notification/listNotifications.ac
notification={
    "userId": "4021",
    "sensorId": "MS1",
    "applicationId": "10",
    "criticality": "high",
}
Returns

High criticality notifications for user 4021 about sensor MS1 from application 1

Appendix 3: Water Flavours Application User Guide

This Appendix constitutes a user guide for the Water Flavours application.

This a web application that can be accessed via this link: http://vmwaternomics01.deri.ie:8012/

Landing page

The landing page is an informative page; it simply describes the application as shown in *Figure 51*.

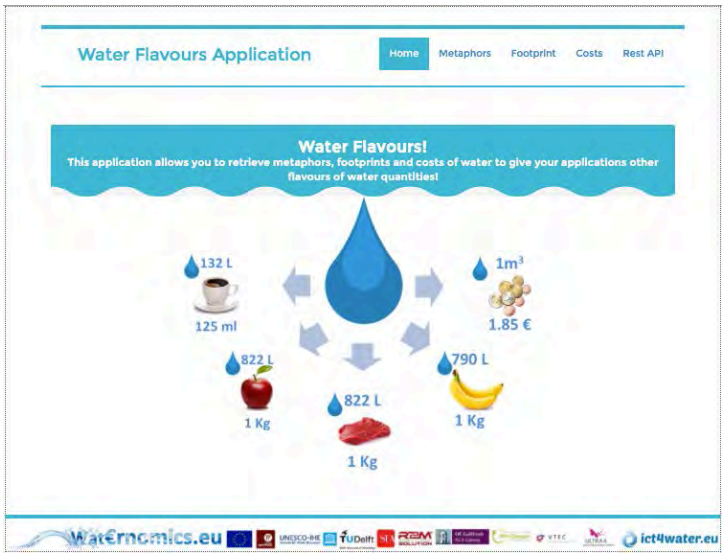


Figure 51: Water Flavours application – Home page

Metaphors page

This page allows creating new metaphors. A metaphor captures equivalence of water quantities to its usage in other contexts. For example 1 L of water can be used to make 4 cups of coffee.

Creating a new metaphor consists of filling the provided form as shown in Figure 52.

As per this form, the user needs to enter that 1 (l or m3) of water is equivalent to (quantity) (unit) of (label); for example: 1 L of water is equivalent to 1 large bottle of Coca Cola. The user is also required to enter a reference (where this equivalence is taken from) and an image to be used in the applications.

After this form a set of available metaphors is listed with the possibility to delete them.

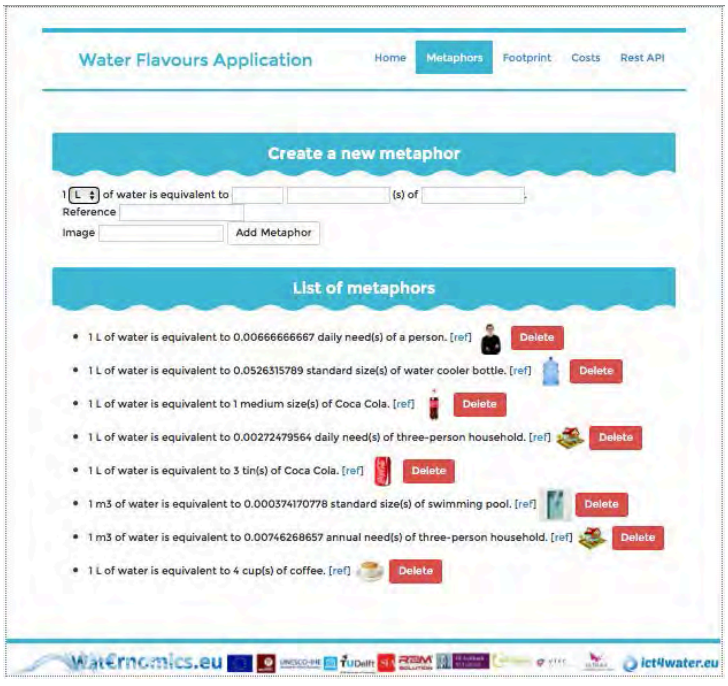


Figure 52: Water Flavours application – Metaphors page

Footprints page

Water footprints measures the amount of water used to produce goods and services we use. This includes single process such as growing fruits and vegetables, for production such as clothes, etc. For example, we need 132 L of water to produce 125 ml of coffee. More details and examples can be found in www.waterfootprint.org.

In this application, managers can create new footprints that are of interest to the end users depending on the context of use. To create a new water footprint, the user needs to fill in the form shown in Figure 53.

As per this form, the user needs to enter that a certain (water quantity) expressed in (L or M3) of water is required to produce (quantity) (unit) of (label); for example: 822 L of water is required to produce 1 Kg of apple. The user is also required to enter a reference (where this footprint is taken from) and an image to be used in the applications.

After this form a set of available footprints is listed with the possibility to delete them.

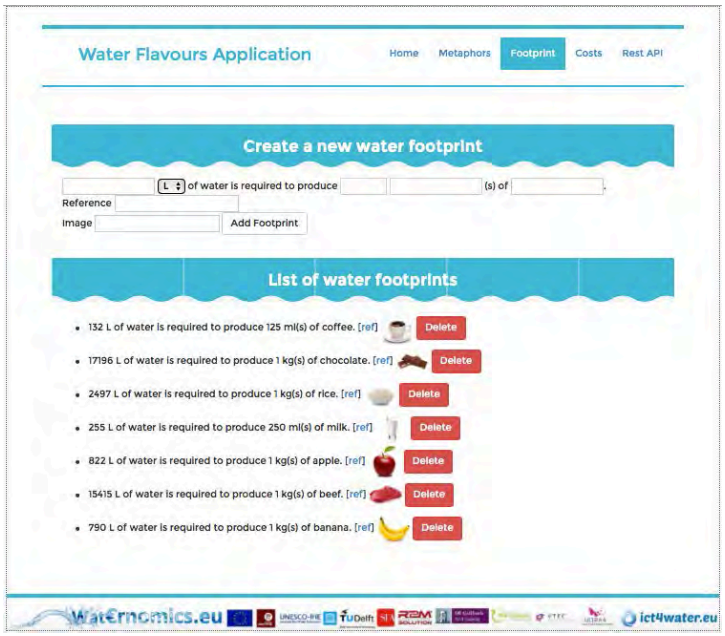


Figure 53: Water Flavours application – Footprints page

Costs page

One of the important perspectives of interests for end users is the financial perspective. Some users are more sensitive to this information and might take water saving decisions based on this information. Different for footprints and metaphors, costs are depending on the country where the user lives and prices fixed by utilities. This application allows to create prices for countries using data from the utility billing information.

To create a new cost for a particular country, the user needs to fill in the form shown in Figure 54.

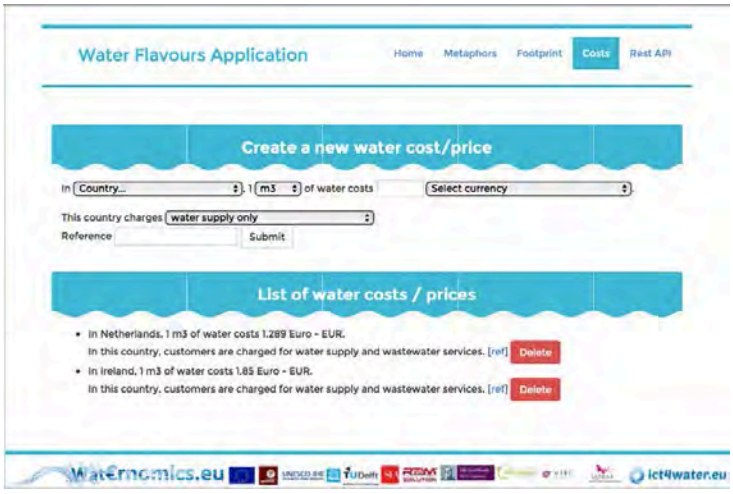


Figure 54: Water Flavours application - Costs page

As per this form, the user needs to enter that in a (particular country) 1 (L or M3) of water costs (amount) (currency); for example: in Ireland 1 M3 of water costs 1.85 Euro. Furthermore, the user needs to specify if this costs counts once (only water supply charge) or twice (water supply and wastewater management charge). For example in Ireland 1 m3 of water would costs 1.85 * 2 as customers are charged on water supply and wastewater management. The user needs also to provide a reference for this information regarding costs.

After this form a set of available costs is listed with the possibility to delete them.

Rest API page

This application exposes its data in the form of json. This data can be accessed via a simple rest API.

Getting the list of defined metaphors can be accessed via the link http://vmwaternomics01.deri.ie:8012/restapi/getmetaphors

The results are returned as json frmat as follows:


```
[{
	id: -7481799711360196,
	qt: "m3",
	value: "0.00746268657",
	unit: "annual need",
	label: "a three-person household",
	reference: "http://www.ccwater.org.uk/savewaterandmoney/averagewateruse/",
	image: "http://tse3.mm.bing.net/th?id=OIP.Mbd10fbdd8710848c26a9847efca59ca0H0&pid=15.1",
	description: "1 m3 of water is equivalent to 0.00746268657 annual need(s) of a three-person household."
}]
```


Getting the list of defined footprints can be accessed via the link http://vmwaternomics01.deri.ie:8012/restapi/getfootprints

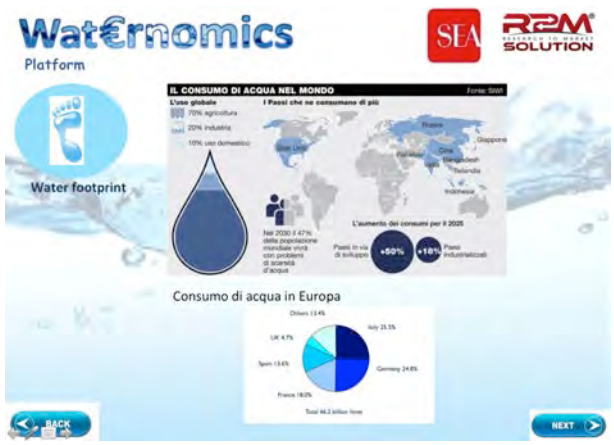

```
[{
	id: -8676443896393788,
	wqt: "132",
	wunit: "L",
	value: "125",
	unit: "ml",
	label: "coffee",
	reference: "http://waterfootprint.org",
	image: "http://wfn.project-platforms.com/product-gallery/images/coffee.jpg",
	description: "132 L of water is required to produce 125 ml(s) of coffee."
}]
```


Getting the list of defined costs can be accessed via the link http://vmwaternomics01.deri.ie:8012/restapi/getcosts

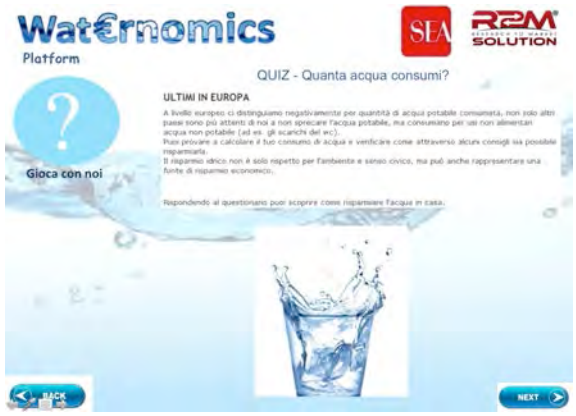

```
[{
	id: -7654385277100987,
	country: "Ireland",
	unit: "m3",
	value: "1.85",
	currency: "Euro - EUR",
	service: "water supply and wastew      ater services",
	reference: "https://www.water.ie/billing-and-charges/charges/",
	description: "In Ireland, 1 m3 of water costs 1.85 Euro - EUR.<br> In this country, customers are charged for water supply and wastewater services."

}]
```

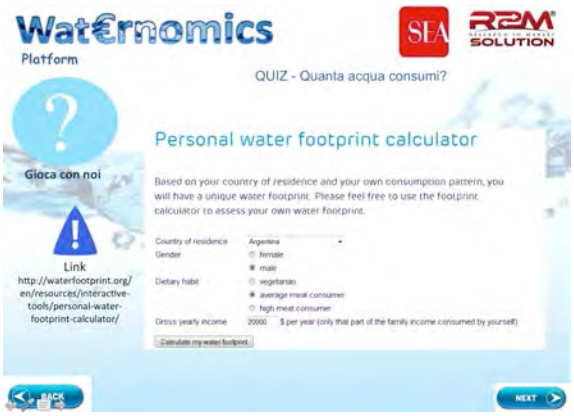
Appendix 4: Linate public display content architecture

The appendix A is intended to show how each section of the web based app will be structured according to the objectives previously described.




Wat€rnomics
Platform
SEA
R2M SOLUTION
Water footprint
SEA da completare con propri contenuti: From Energy to Water Saving
airport carbon accredited
BACK
NEXT


Wat€rnomics
Platform
SEA
R2M SOLUTION
QUIZ - Quanta acqua consumi?
Gioca con noi
ULTIMI IN EUROPA
BACK
NEXT


Wat€rnomics
Platform
SEA
R2M SOLUTION
QUIZ - Quanta acqua consumi?
Gioca con noi
Personal water footprint calculator
Based on your country of residence and your own consumption pattern, you will have a unique water footprint. Please feel free to use the footprint calculator to assess your own water footprint.
Country of residence
Gender
Dietary habit
Gross yearly income
Link
http://waterfootprint.org/en/resources/interactive-tools/personal-water-footprint-calculator/
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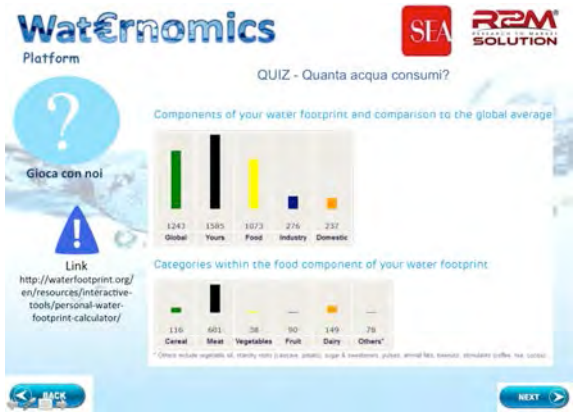
Wat€rnomics
Platform
SEA
R2M SOLUTION
QUIZ - Quanta acqua consumi?
Gioca con noi
Components of your water footprint and comparison to the global average
Categories within the food component of your water footprint
Link
http://waterfootprint.org/en/resources/interactive-tools/personal-water-footprint-calculator/
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R2M SOLUTION
Domande su sezioni precedenti?
Decidere con SEA
Gioca con noi
Alcuni esempi
1) Conosci il paese europeo con minor consumo di acqua?
•Italia
•Francia
•Grecia
1) Cosa è il Water Footprint?
• il consumo di acqua procapite giornaliero
• il consumo di acqua di un paese europeo
• la quantità di acqua utilizzata, direttamente o indirettamente, nelle merci che consumiamo.
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Perchè risparmiare acqua
CONSIGLI PRATICI PER RIDURRE IL CONSUMO DI ACQUA
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Perchè risparmiare acqua
PERCHÉ RISPARMIARE?
risparmiare acqua per risparmiare DENARO:
risparmiare acqua per risparmiare ENERGIA:
risparmiare acqua per risparmiare I COSTI DI GESTIONE DELLE ACQUE REFLUE:
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Perchè risparmiare acqua
COSA POSSO FARE?
CHIUDI IL RUBINETTO QUANDO NON SERVE:
UTILIZZA MISCELATORI D'ARIA:
USA LA LAVATRICE E LA LAVASTOVIGLIE A PIENO CARICO:
CONTROLLA LE PERDITE:
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Consumi Live Sottoforma di metafora criptata (Proposte ?)
Volume di acqua captata da un pozzo dell'aeroporto di Linate
XXX mc/mese
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R2M SOLUTION
Cosa è WATERNOMICS
Il crescente interesse per la risorsa idrica
Studi effettuati dalla Commissione europea hanno rilevato che una parte significativa dell'Europa soffre di stress idrico, che gli impatti cumulativi dello sviluppo economico e dei cambiamenti climatici rischiano di aggravare la situazione in molte aree dove esiste già stress idrico e che parti significative di ulteriore Europa sono suscettibili di essere colpiti in futuro. Gli stessi studi hanno individuato un potenziale molto significativo per il risparmio idrico attraverso una migliore efficienza idrica e l'uso di tecnologie ICT.
Le tecnologie ICT consentono di implementare delle nuove strategie di gestione delle risorse idriche migliorando la gestione delle infrastrutture.
Waternomics cerca di avvicinare gli stakeholders alle tecnologie ICT dimostrando il potenziale di queste tecnologie in casi studio reali tra cui è inserito anche l'aeroporto di Milano Linate.
Milano Linate
OÉ Gaillimh NUI Galway
ΔΗΜΟΣ ΘΕΡΜΗΣ
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SEA
R2M SOLUTION
Cosa è WATERNOMICS
Obiettivi del progetto WATERNOMICS
Lo scopo del progetto WATERNOMICS è quello di introdurre tecnologie ICT innovative nel settore idrico con le finalità di fornire informazioni personalizzate e per gli utenti finali sul consumo e la disponibilità di acqua in modo da incrementare il risparmio idrico. Gli obiettivi del progetto includono:
1 Increase users awareness: sensibilizzare gli utenti sull'importanza della risorsa idrica
2 Engage the consumers: coinvolgere gli utenti in modo innovativo cercando di ottenere un minor consumo di acqua
3 Water network real time monitoring: monitoraggio costante dei consumi idrici al fine di verificare sul campo I targets del progetto
4 Water footprint: introdurre il concetto di Water footprint nella gestione delle risorse idriche
Learn more
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Cosa è WATERNOMICS
Casi studio del progetto WATERNOMICS
Domestic
Corporate
Public
Promuovere l'importanza dell ICT in casi studio reali
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Platform
SEA
R2M SOLUTION
Cosa è WATERNOMICS
Casi studio del progetto WATERNOMICS: Milano LINATE
Metering locations audited and planned
Milano Linate
Technical visits and roundtable discussions with end-users
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Waternomics Newsletter
WATERNOMICS NEWSLETTER
Lascia un commento qui
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Appendix 5: Water Retention Time Observer User Guide

The water retention time is an indicator of the freshness of water in the pipes. If the water has been residing for more than a certain period, it is not recommended to drink it. To detect such situations, the Water Retention Time Observer allows domain experts, usually building managers, to define rules for water retention time on drinking water pipes in order to trigger an alarm when necessary.

This application is developed as a web application that is accessible through this address: http://vmwaternomics01.deri.ie:8010

Landing page

After a successful login, the building manager sees (as shown in Figure 55) the counters over the rules created, sensors that are continuously observed as well as the alarms that have been detected by the application.

Figure 55: Retention Time Observer - Landing page

Rules page

If the manager wants to add a new water retention time rule, he can access the rules page. As shown in Figure 56, this page lists the set of predefined rules. These rules can be either active or stopped. Creating a new rule can be done by clicking on the “Add a new rule” button.

Figure 56: Retention Time Observer - Rules page

A rule is defined with respect to the inactivity period observed by a particular sensor. It can be defined by filling in the provided form as shown in Figure 57 .

For example a user can enter: Create an alarm when the sensor (sensorID) observes an inactivity period of more than (days) day(s) and (hours) hour(s).

In most of the cases, if the alarm has not been resolved, it should expire after a certain period in order to trigger a new one in order to get more the attention of the building managers. This can be defined in the same page by indicating: This alarm expires after a certain period.

The building manager, using his expertise, can define a way to resolve this alarm. Main he needs to define for how long a person needs to keep the water flowing on a particular fountain in order to guarantee that the water in the pipes becomes fresh. This can be defined in the same page in the lower part of the form by indicating: In order to resolve this problem, a person has to keep the water flowing from the tap located nearby for about (minutes) minutes.

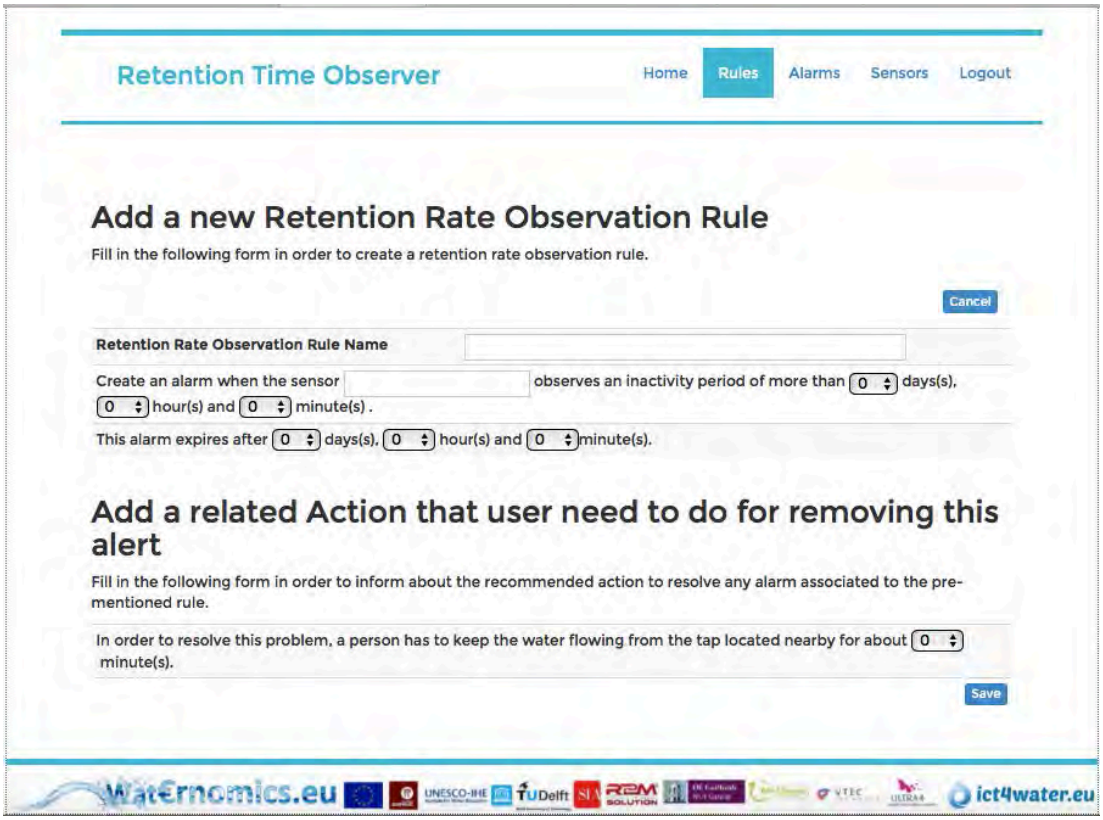

Figure 57: Retention Time Observer - Create a new rule page

Alarms page

For logging and system performance evaluation, the application keeps a log of all detected alarms. The alarms page, shown Figure 58, lists all the alarms, classified by category: active, resolved and expired alarms.

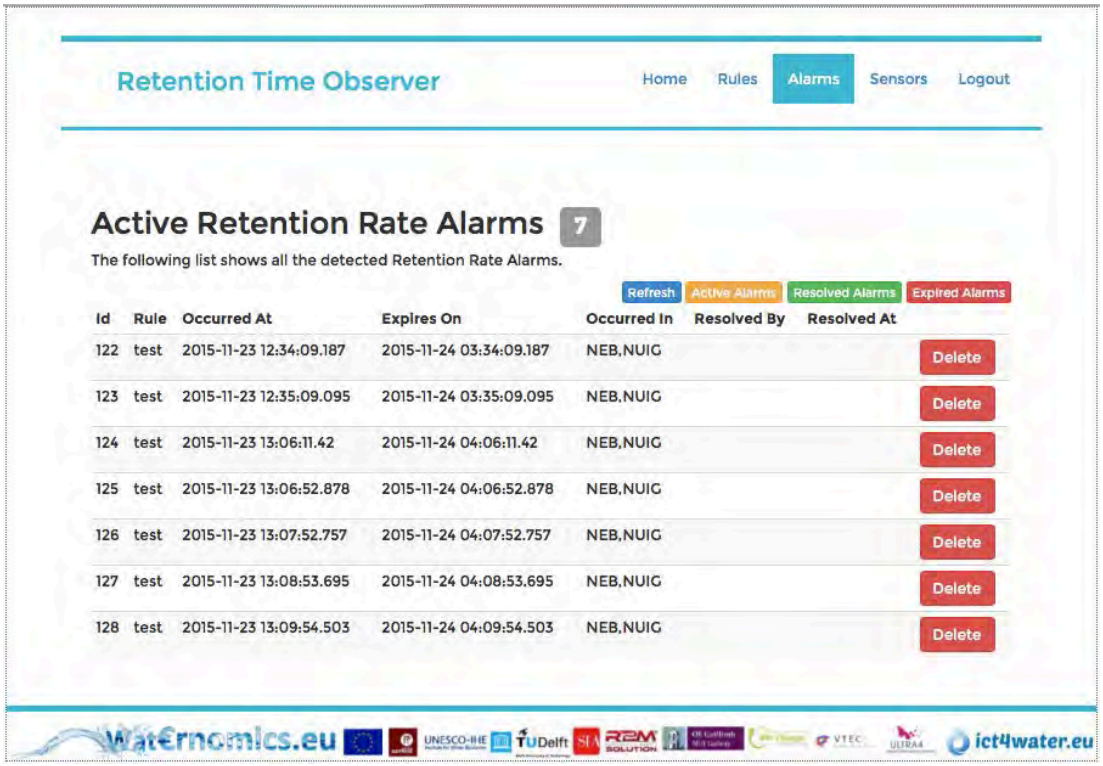

Figure 58: Retention Time Observer - Alarms page

Sensors page

The sensors page, as shown in Figure 59, lists all sensors that are currently observed by the system. The building manager can check this page in order to verify what sensors observing drinking water pipes are continuously verified.

Figure 59: Retention Time Observer - Sensors page

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