MOBISTYLE makes energy efficiency understandable by providing users attractive personalized information on energy use, indoor environment, health and lifestyle

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Most of today's buildings are equipped with sophisticated building automation systems and sensors. They measure large amounts of different building performance data types (mostly related to building's energy performance or thermal comfort). This data is commonly used for energy management of large commercial buildings. However, this data is often not available or understandable to the building users, especially residents. Experience shows that promoting the importance of a building's energy efficiency as such is not an attractive driving factor for changing everyday habits and lifestyle of the building users. However, changing the user's behaviour towards more energy efficient building usage could contribute towards achieving one of the main targets of European Union: reducing energy consumption and eliminating energy wastage. Combining information on energy use with other relevant information such as the indoor environmental quality, personal health and eventually combined with other attractive life style information can be used to catch the interest of consumers and even more importantly change their behaviour and maintain their new habits and interest in the long term.

How can we make sure (or increase the probability) that end-users actually start using the developed tools and change their behaviour towards a better tomorrow? In order to answer this question, the MOBISTYLE project was developed.

The overall aim of MOBISTYLE is to raise the awareness of people and motivate behavioural change by providing attractive personalized combined knowledge services on energy use, indoor environment, health and lifestyle, by ICT-based solutions. Providing more understandable information on energy, health and lifestyle will motivate end-users to change their behaviour towards optimized energy use and provide confidence in choosing the right thing. It will offer people more and lasting incentives than only information on energy use. At this moment,

we have developed 3 tools in the MOBISTYLE project: An expert tool, a dashboard and a game. In this article we will tell you about the expert tool and the dashboard we have developed for this and how they work.

The Dashboard

How & why we developed this dashboard

The Dashboard is a tool that allows different kind of users to receive information about the buildings they interact with, through specific authentication. Different kinds of parameters are received by the building through sensors, and they are shown into the tool. The purpose of the dashboard is to:

1. Actively involve users
2. Raise awareness in users
3. Motivate change behaviour
4. Stimulate energy usage reduction and IEQ improvement
5. Give as much information as possible
6. Create a feedback loop that improves knowledge and awareness into users

When people are living in building, they generate a lot of different of building information. But they have no access to them in an easy manner, or it's not available at all. I.e. in houses: energy consumption data are available only reading directly the meter which is usually not in the apartment, or in the consumption bill; in shared buildings as offices and universities: energy consumption data are not available to occupants.

IEQ is even less monitored in buildings.

Even if energy and IEQ information can be accessed in an easy manner, people usually don't know how to change their behaviour in order to improve performances.

The development of the dashboard

The first version of the dashboard was developed as "things connector" with the objective to connect appliances and to show real time data. The things connector had been shown as a first mock-up of the dashboard to partners through focus groups. A list of suggestions coming from potential users had been produced. The Dashboard was tested both in the Italian and Slovenian demonstration case and, in general, it was very much appreciated. Appreciations came mainly for the opportunity to see different groups of data all together in a single virtual space, including energy consumption of different objects, spaces, and appliances health, and IEQ. Some suggestions for improvements had been received, mainly related to the fact that showing numbers is not a user-friendly solution. Something more visual was of interest and it was suggested to add trends about data changes during time. So easy to understand widgets and active suggestions notifications had been proposed as improvements.

Who will use the dashboard?

The Dashboard Is thought for organizations that manages different rooms and buildings, such as: Housing associations, real estate agencies, municipalities, contractors, hospitals, elderly people rest houses, universities, offices, hotels & short rent apartments. Users can be owners, managers, occupants.

Thanks to the dashboard, users will be able to have access to different rooms and to different data through highly personalized dashboards. Users also receive suggestions about how they can improve performances, reduce energy consumption and improve IEQ.

Using the dashboard

The development of the MOBISTYLE dashboard has defined following features:

1. Customizable sensorized entity structure
2. Articolated users / actors structure
3. Customizable suggestions management

Customizable sensorized entity structure

Sensorized entities can be rooms, apartments, buildings, single smart appliances, personal wearable devices, and so on. It refers to any entity which can be sensorized. The sensorized entities structure is made of: *Sensorized entity type*, which defines the structure and behaviour of a group of similar entities, and a single instance of the sensorized entity.

For each sensorized entity type it is possible to define:

1. The list of type of sensors available;
2. The list of type of data to be shown to users;
3. The structures of all the dashboards, which can even be more than one, i.e. one per kind of user.

For each sensorized entity, as for example a single room of a hotel which has 3 identical rooms for 3 different guests, it is possible to define:

1. The entity type it refers to;
2. The sensors instantiation available in the specific entity (i.e. in the specific room);
3. The users connected able to visualize information in the dashboard;
4. The eventual hangout that lock the access to users after a defined period of time.

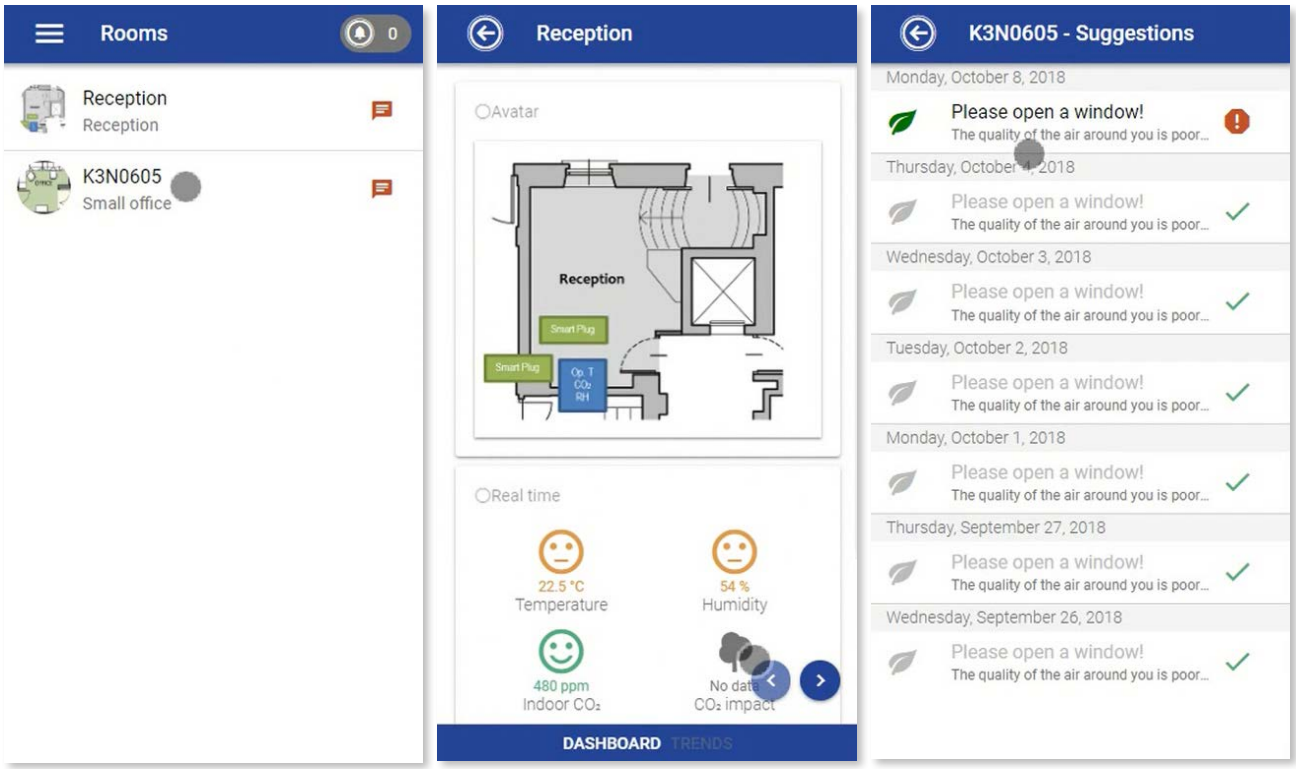
Articolated Users / Actors Structure
There are different types of users and different types of dashboards to visualize data based on the role of the user and their associated entities. Users can be classified in three categories:

- **Admins:** specific for case holders, there is a SuperUser in charge of the overall management of the entities and creation of the dashboard to be shown to the users. The admins are in charge of the account management and they have permissions to create or remove users linked to their organization. They can create new entity types and connect them to the sensor interface. Simple IT skills are required for the role of Admin.
- **Managers:** specific for case holders, it has most of the privileges of the admin, but not the creation of new entity types. Roles:
  - Their first role is to create single sensorized entities, starting from the sensorized entity types created by the company admin.
  - Then they are able to create and modify specific dashboards (i.e. one for the admin/manager, one for the Mobistyle user).
  - They can allocate users to sensorized entities and relative dashboards and allow and remove access permissions, as the Admin.
  - They can even create new suggestions types for each sensorized entity type.
- **Users:** Users are the receivers of the suggestions. They can access MOBISTYLE user dashboard and visualize all the sensorized entities data they are connected to, for the time they are allowed to. They cannot change the dashboard structure. They receive the suggestions and notifications for the sensorized entity they are connected to.

Customizable suggestions management
For each sensorized entity type, the admin and the moderator are able to create different suggestions type. **The suggestions type** is the group of rules that enables the creation and deactivation of suggestions. Each suggestion type is related to a single parameter. They are described by:

- A symbol and color code
- A message title
- A message content
- Starting rules (parameter + operator + value)
- Ending rules (parameter + operator + value)

The single instantiation of the suggestion is created according to the rules, and for each single sensorized entity. It is visible to all the users that have access to the sensorized entity, only for the period of time in which they are allowed to access.



How we use the dashboard

The dashboard is actually in effective usage at the Slovenian and Italian demo cases, which are respectively a University and an Hotel. The professors at the university are testing the usage of the desktop application, having connected their personal office room. In the Italian case the guests of the hotel are involved to download the mobile app and to use it during their stay at the hotel. Testing activities are ongoing and they will be grouped and analysed at the end of the validation process.

The game

The MOBISTYLE Game App is a gamified app for behavioural change on energy use and for awareness creation on associated health benefits. The aim of the Game App aligns with the overall aim of the MOBISTYLE project of raising consumer awareness and motivating a behavioural change on energy use, indoor environment, health and lifestyle.

The App translates collected data from the home sensored environment into more understandable information for the home residents.

The design of the MOBISTYLE Game App followed the project's people centric approach, hence there was a close collaboration with the demonstration case holders (Denmark and Poland) and support from the consortium health and energy experts.

First, in close collaboration with project partners, HighSkillz defined the intended behaviours to be incentivised via the MOBISTYLE Game App. Then following iterative feedback loops with experts and end-users the design and development of the solution was informed. During this process a set of tools were used in order to facilitate the discussion, explain concepts and collect feedback, such as storyboards and different types of mockups. Following this approach all the MOBISTYLE Game App mechanics and objectives were validated by the consortium domain experts.

Who will use the game?

The MOBISTYLE Game App addresses the two residential demonstration cases (Poland and Denmark) and it is meant for home residents.

The MOBISTYLE Game App follows an approach centred on home-specific conditions and actions, based on the concept of maintaining a "healthy" home. This means that all users of the Game App associated with a specific home will share the same state and progression.

Using the game

Goals and Missions

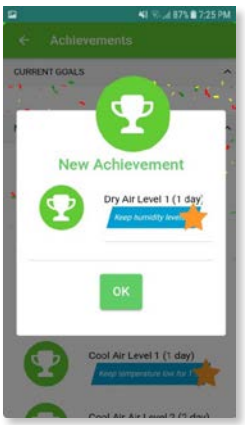
The adopted gamification approach for the MOBISTYLE Game App is focused on home-centric sensorized gamification, aiming to influence the user behaviour on energy efficiency, indoor environmental quality and health. Towards this goal the MOBISTYLE Game App incorporates a set of goals on energy efficiency for its users.

Each one of these goals is linked to relevant energy missions – actions encouraging user behaviours. The Game-App incorporates two types of missions:

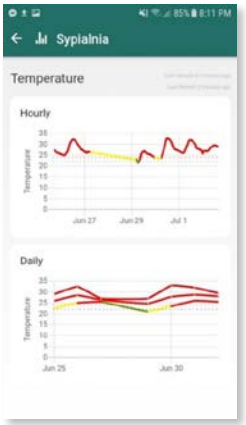
- Real-time missions: When certain adverse conditions are detected, digital "nudges" that encourage the user to take recommended actions are triggered. Such missions refer to indoors temperature, relative humidity and CO_2 levels.
- Deferred missions: In these missions a period of time is analysed in order to provide recommendations for the next similar period.

In addition to focusing on behaviours that can be triggered and detected via sensorized data, there is also a strong focus on providing notifications and actions' recommendations that are relevant to the user. This approach reduces the likelihood of users abandoning the Game App due to disturbance from indiscriminate alerts leading to the app being ignored or even uninstalled.

Points and Ranking
The implemented score is based on "MobiPoints", which is an indication on how close a home is to being "healthy". A top level in MobiPoints means that no mission or problems were detected in any of the rooms. Based on their MobiPoints the users are also shown their home's ranking in their region.

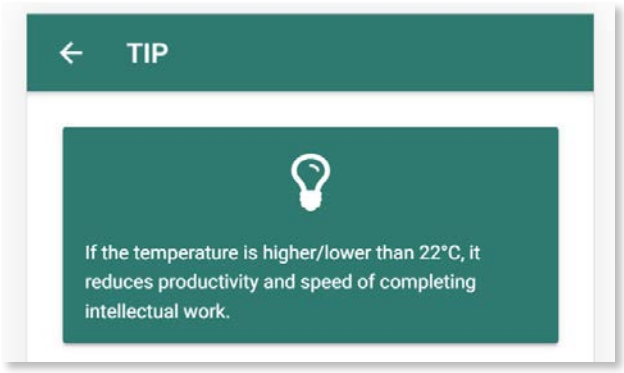


Achievements
Achievements refer to long-term sequences of actions where the user is consistent in achieving certain goals over a period of time (streak). Achievements have the form of medals for healthy CO_2 air levels, temperature values and relative humidity levels inside the homes.



Reports
The MOBISTYLE Game App user is provided with intuitive chart-based information on their home performance. These reports are tied to recommendations whenever possible.

Tips
In addition to the goals and missions related to energy efficiency, the user is also provided with a list of health tips to encourage healthier lifestyles in association to energy efficient behaviours.



How we use the dashboard
The design and development within the scope of the MOBISTYLE project resulted in five goals being assigned to the Polish demonstration case and four goals for the Danish demonstration case. These decisions were informed by the available sensors and data for each demo case, as well as the sensor-based gamification approach.

The Expert tool

How & why we developed the expert tool.

Within the MOBISTYLE project, the need to develop the Expert Tool came directly from the experts within the consortium who needed to access the data from the different demonstration cases in order to perform the expected analysis assessing the behavioural change of the building users after putting into place the MOBISTYLE approach and tools.

Due to low cost sensor techniques the amount of data collected from various physical quantities is expanding rapidly. In the construction sector, building managers and owners deal with a lot of different data and information – such as sensors data, smart meter data, and energy bills – coming from different sources and available in different formats. Nevertheless, in some situations this data is easy accessible, available or readable; whereas in other situations the required data can be difficult to extract and difficult to interpret in a homogeneous way.

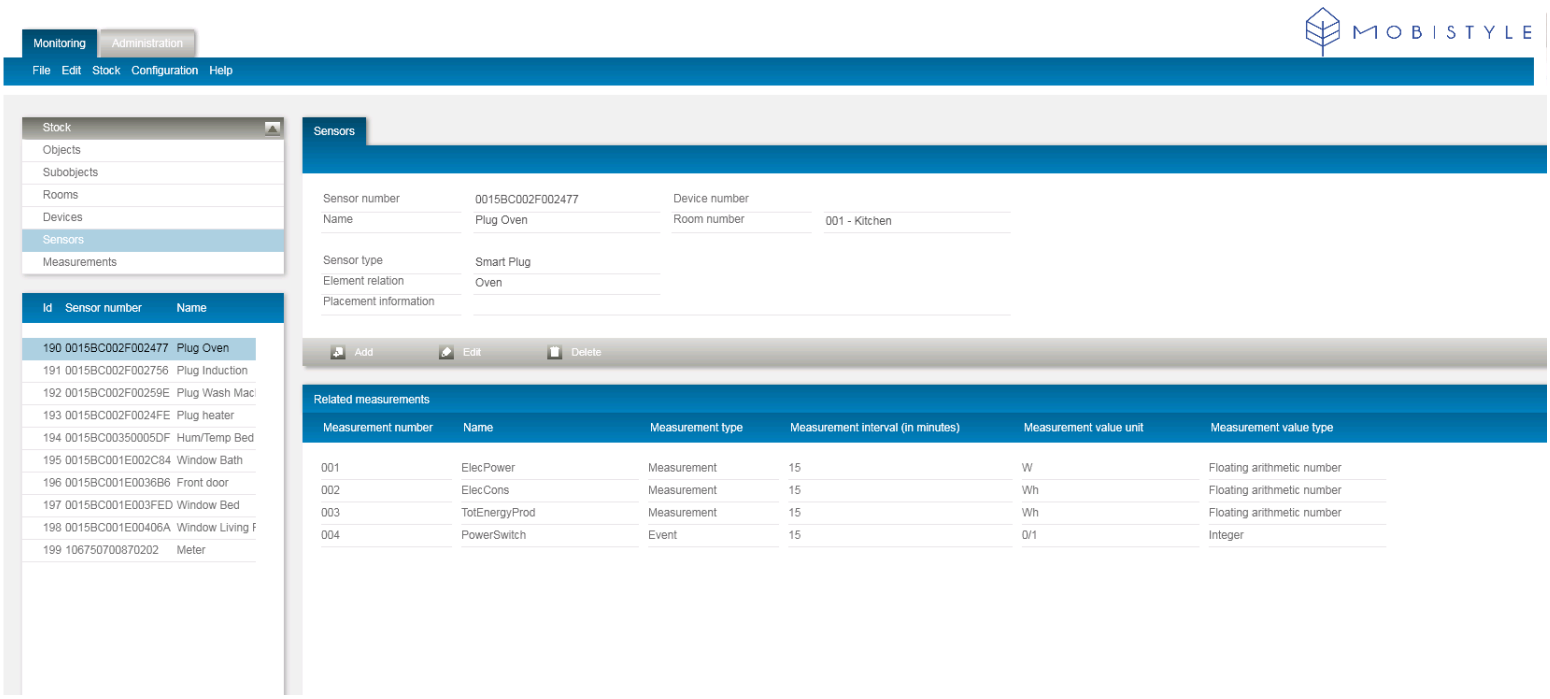
For whom is the expert tool?

The Expert Tool is built upon the existing RE Suite software package developed and commercialized by the consortium partner DEMO Consultants. In general terms the Expert Tool will be an additional module to the RE Suite package for real estate asset management.

Within the consortium as well as outside it, the Expert Tool has as main target groups real estate owners and managers – such as housing associations, real estate agencies, hospitals – i.e. all those entities who need to access an heterogeneous and consistent amount of data and information to monitor the performances of a building and plan maintenance activities.

Within the MOBISTYLE project, the Expert Tool allows the visualization and management of a big

MOBISTYLE



amount of data available in the different demonstration cases. The experts are able to filter the information they need, to calculate pre-defined KPIs, but also to set up their own KPIs. The Expert Tool is design in such a way that it fixes only some boundary conditions, giving the freedom to the user to filter information, make simple calculations, and export the data in the most suitable way.

Using the expert tool

The Expert Tool has 3 main purposes:

1. Data management: the expert has access to the data for visualization, filtering and validation purposes.
2. KPI calculation: the expert is able to visualize and download KPIs on energy, comfort and health.
3. Support the needs of third parties tools: the expert will be able to export the data in the most suitable format. This functionality guarantees the interoperability between the Expert Tool and the other software programs used by the expert for evaluation and analysis purposes.

The expert tool aims to supply experts with the dataset(s) they need. Its purpose is not high-level analysis, but rather offering experts access to data for use in their own tools.

As such, a simple retrieve-and-save-to-disk operation would fulfil the basic theoretical requirements. However, this method quickly proved being insufficient. Therefore, following questions were considered:

- What if an expert only needs part of the set?
- How will an expert know if the result matches their expectations?
- Must they dive into the dataset's depths and do a preliminary analysis?
- How will they even know what to query if they do not know what a dataset looks like?
- What if they need a different kind of aggregation than the predefined ones for the calculation of the KPIs?

To answer these questions, the Expert Tool offers dataset constraints through the use of filtering conditions. Moreover,

- It offers quick verification through visualisation of dataset summaries;
- It offers insight in data sources and their current status;
- It offers the possibility to quickly calculate basic KPIs such as the cost for electricity consumption;
- It offers the possibility to customize the type of aggregation for the calculation of KPIs;
- It exports a verified dataset in some format that is useful to the expert's tools. ■