



D5.2: 1st version of integrated and tested hackAIR open platform

WP5 – Development of the hackAIR platform



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Document Information

Grant Agreement Number	688363	Acronym	hackAIR
Full Title	Collective awareness platform for outdoor air pollution		
Start Date	1 st January 2016	Duration	36 months
Project URL	www.hackAIR.eu		
Deliverable	D5.2 - 1st version of integrated and tested hackAIR open platform		
Work Package	WP5 - Development of the hackAIR platform		
Date of Delivery	Contractual	1 st September 2017	Actual 1 st September 2017
Nature	Demonstrator	Dissemination Level	Public
Lead Beneficiary	DRAXIS Environmental S.A.		
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Document History

Version	Issue Date	Stage	Description	Contributor
1.0	25/07/2017	Draft	First draft	Ioulia Anastasiadou (DRAXIS), Stavros Tekes (DRAXIS), Nikos Gkargkoulas (DRAXIS)
1.2	31/07/2017	Draft	Contributed the architecture	Ioulia Anastasiadou (DRAXIS), Stavros Tekes (DRAXIS)
1.4	07/08/2017	Draft	Contributed App functionality	Ioulia Anastasiadou (DRAXIS), Stavros Tekes (DRAXIS), Efstathios Chatzikyriakidis (DRAXIS)
1.5	11/08/2017	Draft	Revised architecture and summary chapters	Ioulia Anastasiadou (DRAXIS), Stavros Tekes (DRAXIS), Dimitris Messinis (DRAXIS)
1.7	17/08/2017	Draft	Contributed the hackAIR progress chapter and refinements	Ioulia Anastasiadou (DRAXIS), Stavros Tekes (DRAXIS), Dimitris Messinis (DRAXIS)
2.0	23/08/2017	Draft	Review Feedback	Philipp Schneider (NILU)
2.5	23/08/2017	Draft	Review Feedback	Akis (Symeon) Papadopoulos (CERTH), Stefanos Vrochidis (CERTH), Spyromitros-Xioufis (CERTH)
3.5	01/09/2017	Final	Final version	Efstathios Chatzikyriakidis (DRAXIS), Nikos Gkargkoulas (DRAXIS), Stavros Tekes (DRAXIS), Dimitris Messinis (DRAXIS)

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1 Executive summary

This deliverable presents the 1st version of the hackAIR platform and its subcomponents and describes the integration between the components described in the D5.1 deliverable and the core platform.

The web platform can be found at: <http://hackAIR.draxis.gr/> while apps for Android and iOS are uploaded to the respective mobile stores.

More specifically, the deliverable covers the following topics:

- ♥ The general progress towards the development of the 1st version of the hackAIR platform
- ♥ Implementation of the platform's architecture
- ♥ Integration of the various sub-components defined in D5.1, feeding data into the platform
- ♥ App functionality
- ♥ Next steps

2 Introduction

The main mission of the platform is to combine high volumes of sensor readings, images and user inputs, process them and to create new data that are used to deliver reliable air quality information for citizens. The complexity of the attempt to provide those services, proved to be a challenge for the technical team, which was met by having many discussions to establish a common terminology and understanding of the domain and to create a more concrete integration plan than the one initially planned in D5.1.

2.1 Development methodology

The team followed an agile methodology (SCRUM¹) to develop the platform and to have citizens (mainly consortium partners) involved in the process to generate feedback for the team. The team established a backlog² of tasks, based on the user and technical requirements from D2.2, created a sprint³ schedule and started analyzing and working on sprints. The principle chosen regarding the population of the sprints was to create an initial version of the application early in the project, which could be used to demonstrate the hackAIR purpose with all the minimum essential needed functionality. Further sprints and meetings brought the technical team closer to interested citizens and helped bridge the gap in understanding and expectations. The figure below demonstrates the backlog and a developers sprint assignments in the PivotalTracker⁴ web tool, which was used as the development project management tool.

¹ [https://en.wikipedia.org/wiki/Scrum_\(software_development\)](https://en.wikipedia.org/wiki/Scrum_(software_development))

² In SCRUM backlog is a list of features or technical tasks which the team maintains and which, at a given moment, are known to be necessary and sufficient to complete a project. ([Source](#))

³ sprint is the scrum term for iteration

⁴ <https://www.pivotaltracker.com/dashboard>

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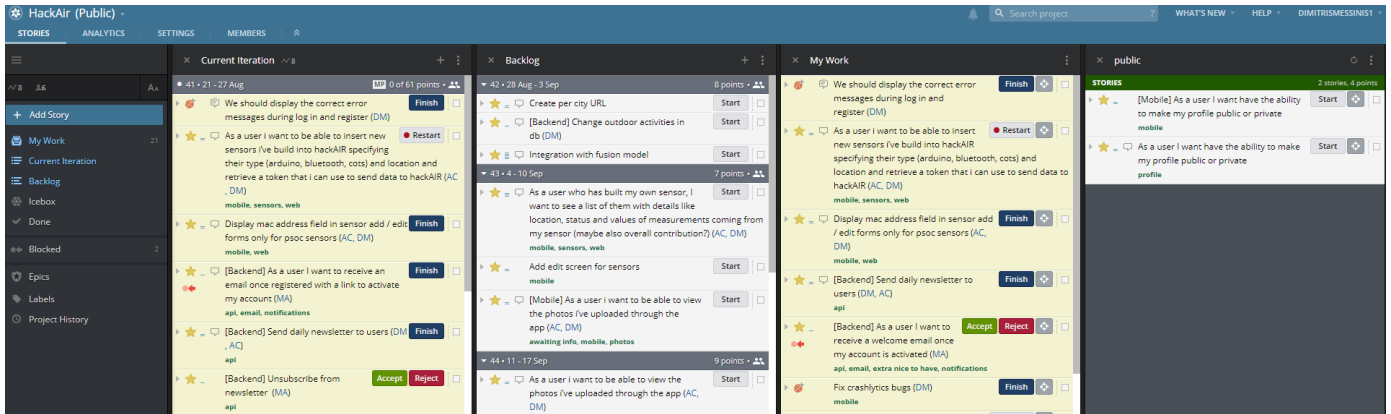


Figure 1 - Development task list (or backlog in SCRUM)

2.2 User experience

A high-level consensus was established among consortium partners that the platform should offer a streamlined experience to its users being friendly and clean, making it easy for them to discover the offered functionality. The team worked on an iterative approach to build the UI based on the user requirements and brought a UI/UX⁵ expert who helped a lot to build an attractive and intuitive set of applications aimed to serve the hackAIR purpose. Initially the team worked on very early designs (Figure 2) and used as a base for discussions in order to gradually conclude on the colors and the final placement of the controls for the various screens. The designs, along with wireframes, were fed into the four co-creation sessions (as described in D2.4) with users similar to the personas examined at the user requirements phase and also with hackAIR internal partners during a consortium meeting. Based on the outcome of those meetings/discussions, the team developed the final user interface and built mockups for all the screens (Figure 3 and Figure 4).



Figure 2 - A very early design

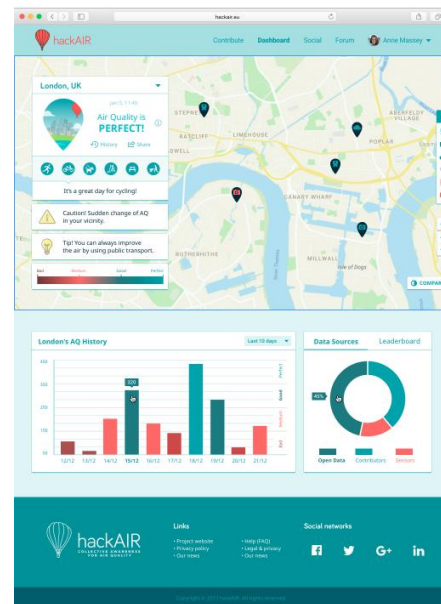


Figure 3 - The final approach

The team followed the “mobile first”⁶ design approach, which is based on the principle: “design first for smaller screens first, then add more features and content for bigger and bigger screens”. That allowed the team to focus to

⁵ User Interface / User Experience - https://en.wikipedia.org/wiki/User_experience

⁶ https://www.lukew.com/resources/mobile_first.asp

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meet the mobile user's requirements on the most basic level because of the constraints of both performance and the landscape of the mobile platform, solving serious issues about content and features provided in each screen.

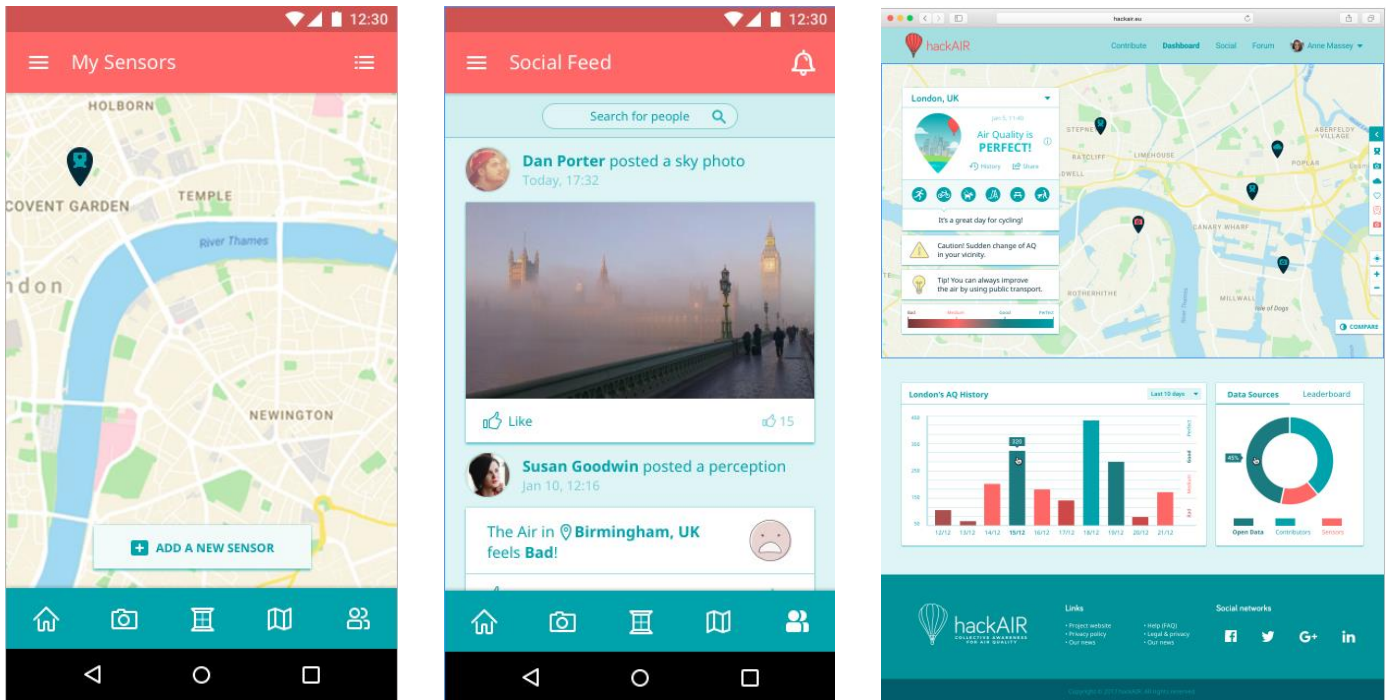


Figure 4 - Screenshots for the web and mobile app

2.3 Integrations

Following up on the D5.1 (Architecture and integration framework definition specification), the team established an integration plan to connect the hackAIR subsystems and to download and process the data needed for the air-quality models. Once the implementation phase started, discussions among the involved partners sparked the need to specify additional details that were important when trying to integrate the components.

Our initial plan involved different approaches (push or pull) for the different services. This sometimes resulted in a cascade of errors when one failed and, therefore, we decided to introduce an orchestrator service which is a service responsible for managing the communication between the other services/components and monitoring the proper operation of all the components. The service orchestrator was developed using the JavaScript language on top of express.js, a web application framework designed for very high speed i/o interaction between data, logic and presentation layers. An indicative orchestrator workflow can be seen at the figure below.

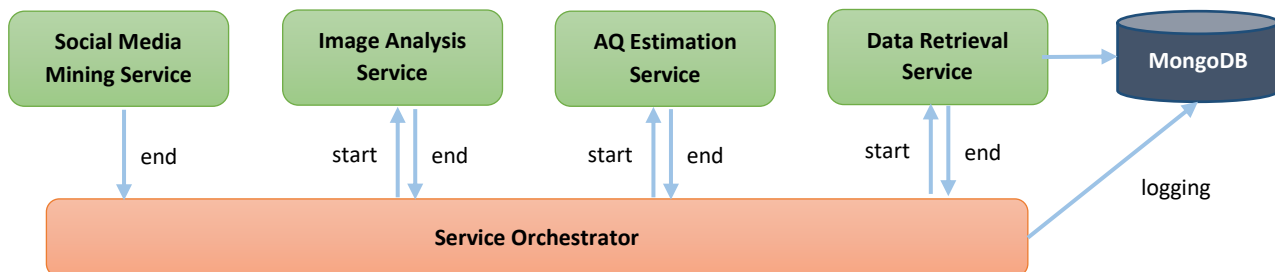


Figure 5 - Example of a flow where the orchestrator involves the execution of several components

2.4 Testing

During the development of the individual components, the team developed the essential mechanisms to test and validate the platform's behaviour compared to the original plan as it was described in D5.1 and reassure that the platform will function securely and reliably.

The testing procedure helped the team track and resolve issues both in code but also in the logic of the events in the platform. Several scenarios were written in paper and some of them were also automated using tools like Selenium⁷ (for the web app) and Appium⁸ (mobile app testing) so the tests can be executed right before a version gets released. Other scenarios were analyzed in steps and were given to pilot users to execute and track any issues or inconsistencies.

The complete list of the scenarios and the steps those include can be found in Appendix II - hackAIR Testing Scenarios. A brief list of those scenarios is presented in the list below:

- Login Web
- Registration Web
- City Choice Web
- Add Profile Information Web
- Share AQ on Facebook Web
- Add New Sensor Web
- Share AQ on Twitter Web
- Missions Web
- Fusion Map Web
- Map Filters Web
- Map Pop-Ups Web
- Registration Mobile
- Login Mobile
- City Choice Mobile
- Add New Sensor Mobile
- Add Profile Information Mobile
- Fusion Map Mobile
- Map Filters Mobile
- Map Pop-Ups Mobile
- Missions Mobile
- Share AQ on Facebook Mobile
- Share AQ on Twitter Mobile

2.5 Localization

As described in D5.1, the mobile and web applications are being translated (with support from all consortium partners) from English into Norwegian and German. This is an ongoing process, as with the addition of more features, more translations are needed.

⁷ <http://www.seleniumhq.org/>

⁸ <http://appium.io/>

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To facilitate the process, the team provided each translation group a CSV file with all the English terms in both apps. A script that automatically parses the translated CSV and converts them to a format the apps can consume was also built, keeping the overhead of the entire process to a minimum.

2.6 Open source

The hackAIR platform is an open source platform allowing developers to download, customize and extend the application. The main project repository is on GitLab, an internal to the consortium

Hub⁹ at the following address:

<https://github.com/hackAIR-project>

One of the foreseen purposes of using hackAIR is the adoption by communities, where they can install the code on their private servers and parametrize it to serve as their own community portal.

An introductory page will be built to GitHub pages for presenting the project to developers.

⁹ <https://github.com/>

3 hackAIR Platform Architecture

The hackAIR platform architecture plan described in D5.1 was followed, with some additions and changes, some of which are presented below. A diagram of the final architecture followed can be seen in Figure 6.

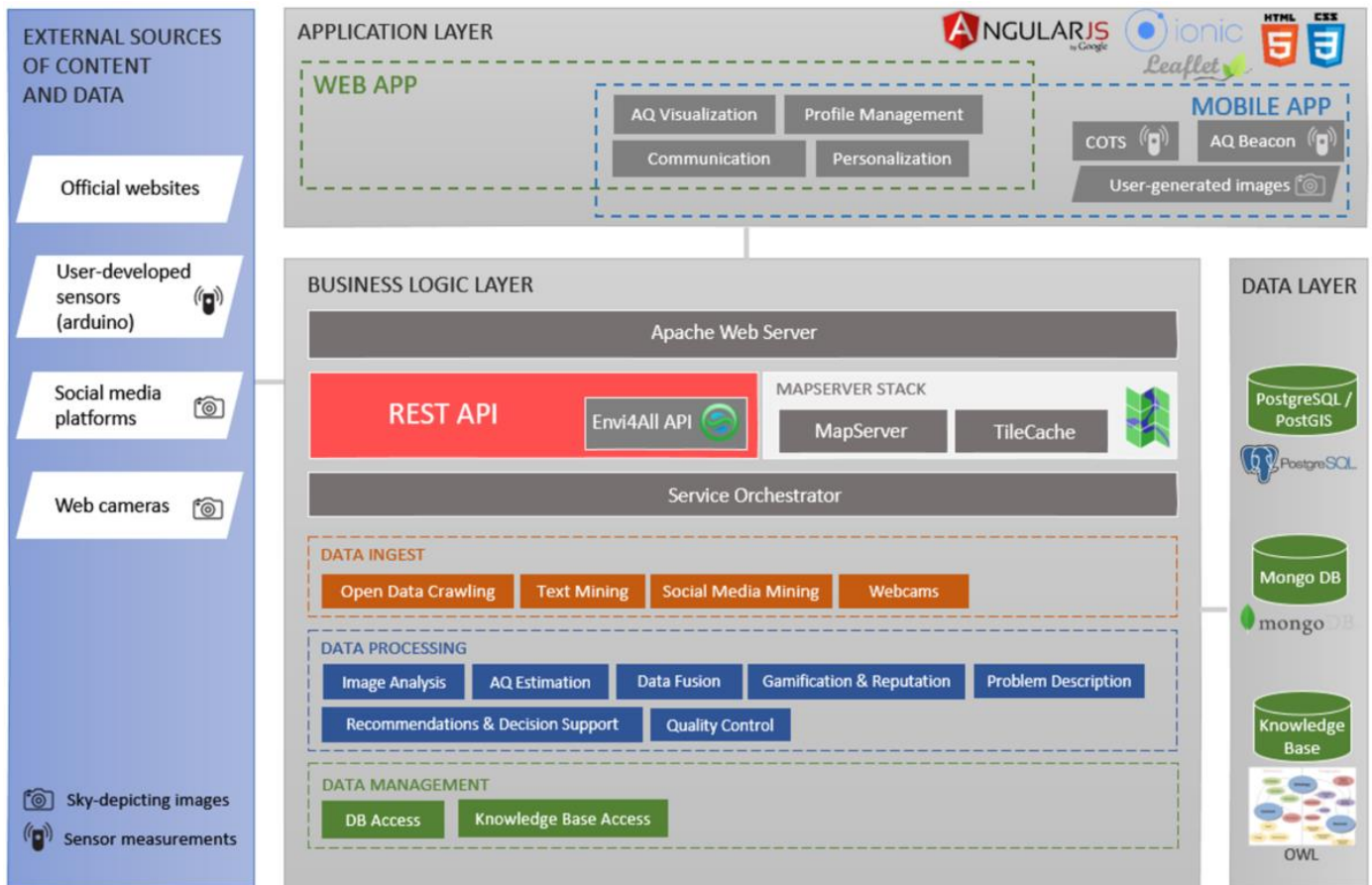


Figure 6 - hackAIR integrated platform

- **Database change**

hackAIR needs a relational database to store any citizens' data, sensor information, AQ data coming from fusion etc. Initially we were planning for MySQL but finally switch to PostgreSQL which has a better support for the fusion spatial data.

- **Mapserver**

Instead of using an online service like google maps as a spatial visualization component for hackAIR, we decided to use mapserver¹⁰ which helps in performance and will allow us to create geographic image maps with custom thematic layers. As an alternative, the team also evaluated Mapnik (an open source toolkit for rendering maps) which proved also able to handle the required work without overloading the server. It is a technology that will also be examined if mapserver cannot perform with the hackAIR load.

- **Application Programming Interface (API)**

The hackAIR API platform provides a RESTful API, through which the front-end application (web and mobile phones) or other application can perform read, create, update and delete operations on the

¹⁰ <http://mapserver.org/>

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platform's data using HTTP requests. The API was developed using the PHP Laravel framework and was described in D5.1 and its documentation can be obtained from <http://hackAIR.draxis.gr:8000/docs>

The hackAIR API extended the Envi4All API, which is an existing commercial air pollution data provider built by DRAXIS. Envi4All¹¹ similarly to hackAIR, uses sensors, citizens' feelings and models to cover for air pollution in the past, the current moment and the future. As most of the functionality covered by Envi4All was also a requirement for hackAIR, the team chose to be based on the Envi4All API in order for the two applications to be able to share a common structure and data pool.

For the creation of the technical documentation (Figure 7) for the hackAIR API the WP team used Swagger¹², a widely-known framework for describing an API using a common language, allowing the API's consumers to discover and understand the capabilities of the service without accessing the source code, documentation, or through network traffic inspection.

HackAIR REST API

Users : User registration, authentication & management Show/Hide | List Operations | Expand Operations

DELETE /users/{userId}

GET /users/{userId}

Implementation Notes
Find user.

Response Class (Status 200)
Successful user retrieval

Model | **Example Value**

```
{
  "code": "200",
  "status": "string",
  "data": [
    {}
  ]
}
```

Response Content Type: application/json

Parameters

Parameter	Value	Description	Parameter Type	Data Type
Accept	application/vnd.hackair.v1+json	API Version header	header	string
Authorization	{required}	Authorization header (Bearer)	header	string

Figure 7 - hackAIR REST API documentation

- **Problem Description module**

In our initial architecture, we described a module that would accept the user query and translate it into PDL (Problem Description Language) which was the format needed by the Recommendations & Decision Support engine to query the Knowledge base. During the development phase, it was decided to merge the two components together and now the Recommendations module translates the user query to PDF which then is fed to the knowledge base.

- **Integration with PSoC sensors**

The technical team faced some difficulties reading measurements in latest android versions due to an old library that could only run on android 4.4. We had to write the library from scratch using an open source cordova library¹³ which allowed reading measurements both on Android and iOS.

¹¹ <http://www.envi4all.com/>

¹² <http://swagger.io/>

¹³ <https://github.com/randdusing/cordova-plugin-bluetoothle>

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- **Integration with arduino sensors**

There were difficulties reading measurements from the second batch of Arduino sensors that were distributed internally to partners. The problem was caused by an Arduino firmware that was not sending the sensor's authorization token to the REST API, which was planned to be used to identify the sensor sending measurements. This caused an initial low number of measurements from Arduinos in our dataset but was later fixed after a firmware upgrade to these devices.

- **Scaling up in the UI**

When data started coming at larger chunks we realised that the number of measurements increased over time, causing the map to become cluttered and unresponsive. Therefore, we decided to limit the measurements presented to the most recent ones and also provide hourly averages where possible.

Citizens can now choose from most recent data (defaults), all measurements or hourly averages.

- **Gamification**

One of hackAIR's onboarding¹⁴ and retention strategies relies on gamification. An expert (Mr. Oliver Simko from Luducrafts - www.luducrafts.com) was brought on board to give his insight on how to build a successful gamification case, while another gamification expert Mr. Stavros Lounis, who is member of the hackAIR External Expert Advisory Board was further consulted. Our gamification strategy involves a combination of missions that, when completed, results in citizens gaining badges. In addition, the use of narratives helps citizens understand the hackAIR concept and levels provide a sense of progression.

Details of the followed strategy can be seen in Appendix I - Gamification strategy.

- **Integration and communication plan**

The technologies chosen for building the different modules responsible for the integration and visualization of the hackAIR platform to citizens are presented in the table below:

Table 1 - Technologies used for the integration

Modules	Technology used
Rest API	PHP using Laravel API + Envi4All API
Database storage	Postgress/PostGIS, MongoDB, OWL
File Storage	A common file storage based on Linux
GIS server	MapServer
Web App	AngularJS, Leaflet
Mobile App	Ionic to build natively for Android, iOS

¹⁴ Onboarding is the process of initially explaining a new product to first-time users, and "showing them the ropes" when it comes to the product's functionality. ([Source](#))

4 App functionality

This section presents some of the basic functionality of the 1st version of the hackAIR platform that will be used by the pilot users to evaluate and test the main platform functionalities.

After registering, the users land on the dashboard where they can choose a city and see the Air Quality Index (AQI) of that city. By enabling or disabling filters on the right panel (Figure 8), they can see sensors of their own or from other users and sky pictures taken that contribute to the overall calculation of the AQI and the historical diagrams. On the left panel, users can see personalized recommendations regarding their outdoor activities (working/ eating/ doing sports/ playing outdoors) that depend on their selected profile and the current air quality. On the same page, users can see diagrams of the historical air quality levels (for the previous week, month or year) in order to understand how the air pollution evolved over time in the city of their interest (Figure 9).

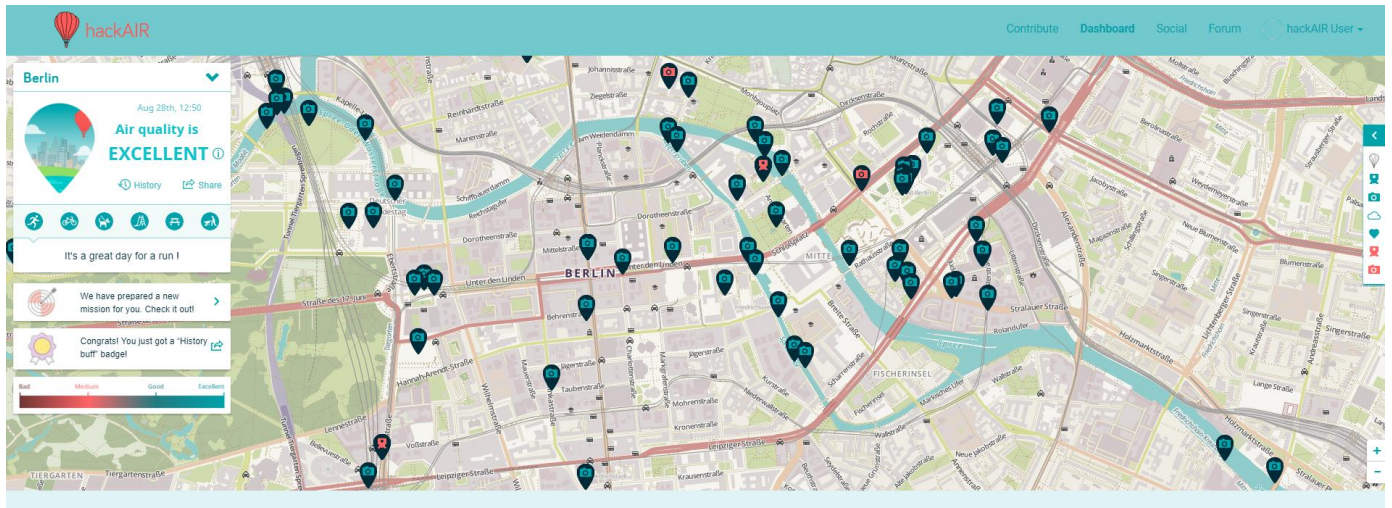


Figure 8 – Web app dashboard screen

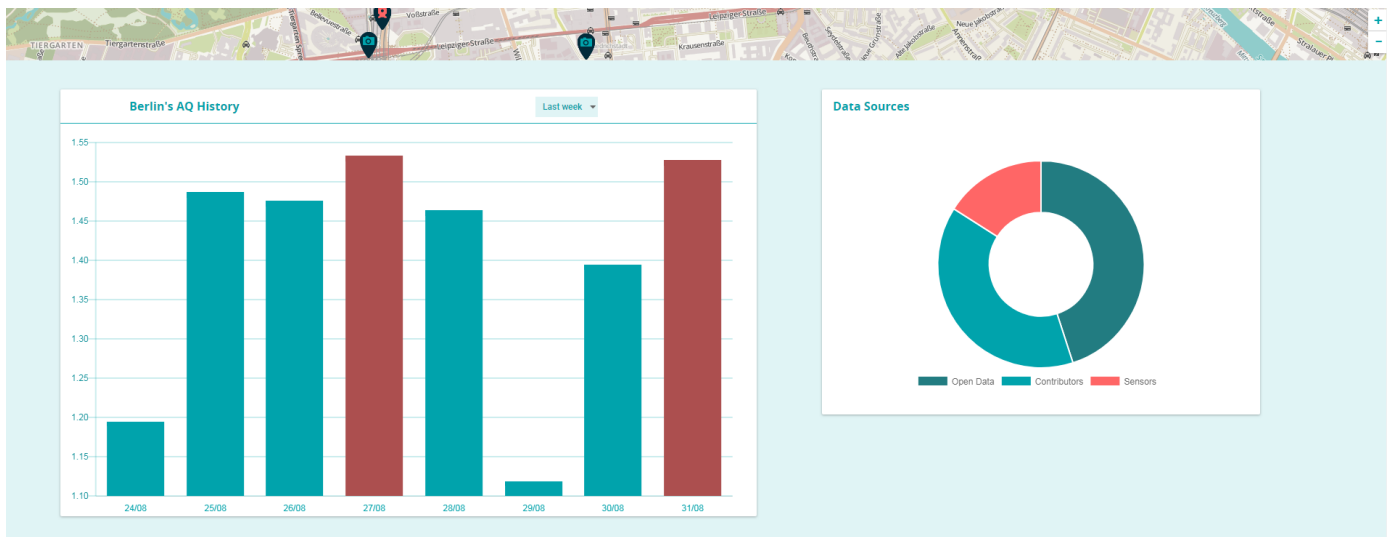


Figure 9 – Historical air quality diagrams on the web app

In general, the same concepts and functionality apply to the mobile platform as well. After registration, the user is redirected into the mobile dashboard page where he/she is able to choose a city and see the current air quality levels. A map was not used on the mobile dashboard in order for the information to be clear and direct. Users can however access a map with the thematic map of the Air Quality Index (AQI) at a separate screen.

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Figure 10 - Mobile dashboard

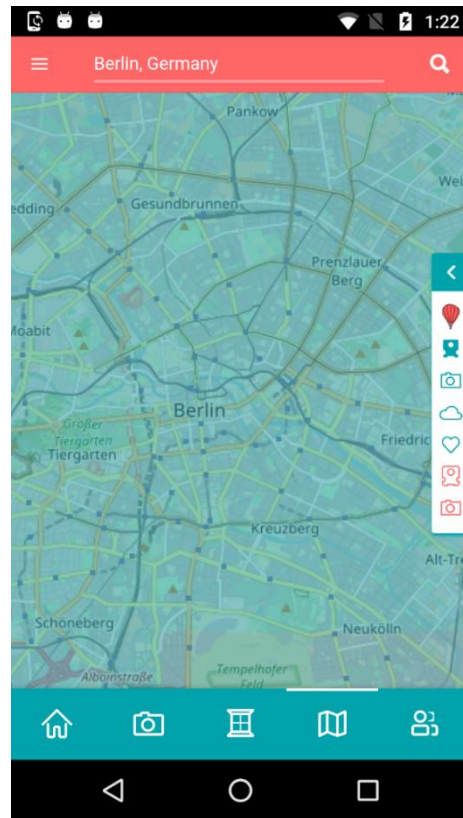


Figure 11 - Mobile AQI thematic map

In the map screen, on both the web and mobile versions, a user can switch on the fusion map filter which will create a color overlay over the map according to the AQI values of the area (for example in the previous and following screens the color is blue which corresponds to an “Excellent” AQI).

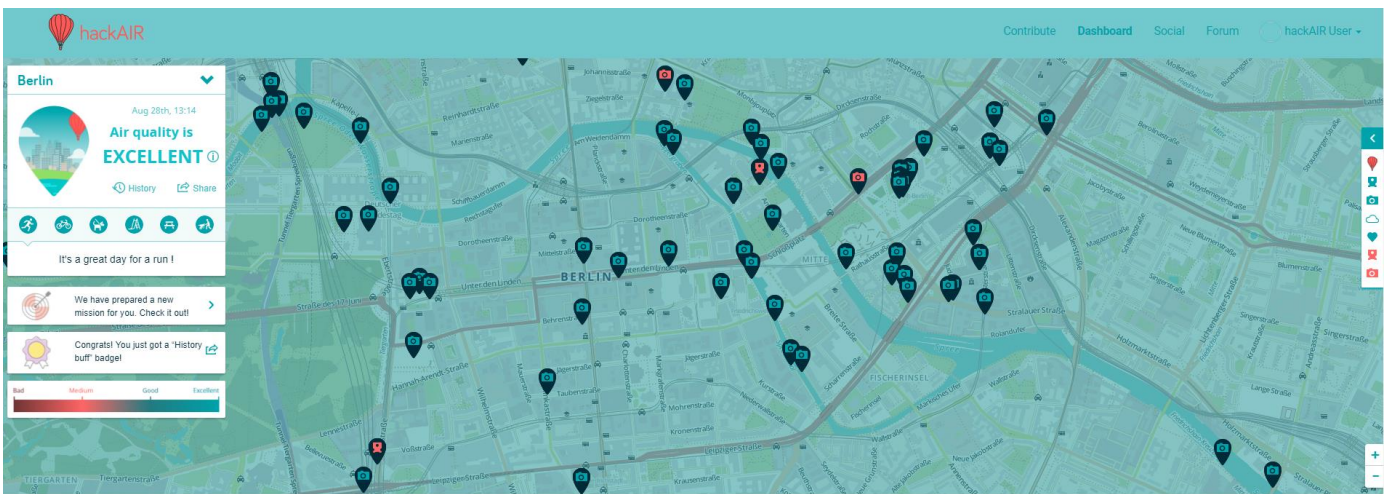


Figure 12 - Web map screen with the AQI painted as a thematic map

For a more engaging experience to the user hackAIR incorporates gamification elements which are mainly accessible on mobile version of the platform (some scenarios also cover the web) and include missions, acquiring badges when completing missions (such as completing your profile) etc. By clicking on a mission, the user can get access to the gamification part of the platform. Available missions are shown to the user to engage him/her to be more active on

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the platform and contribute by taking photos, adding sensors, completing the profile, submitting their perception on the current air quality etc.

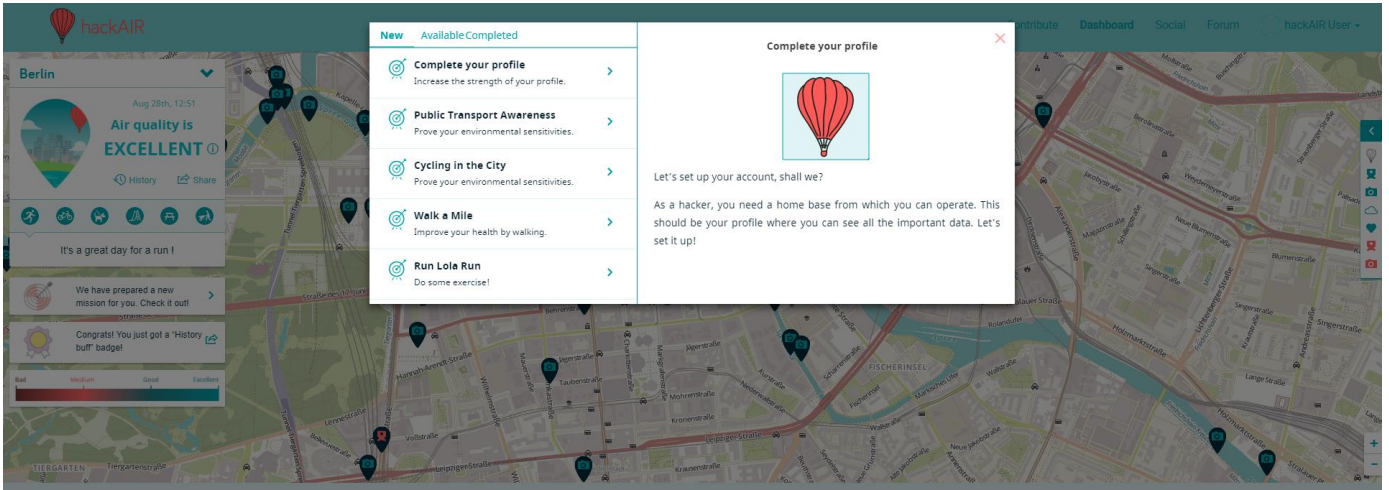


Figure 13 – Overview of the gamification missions at the hackAIR web app

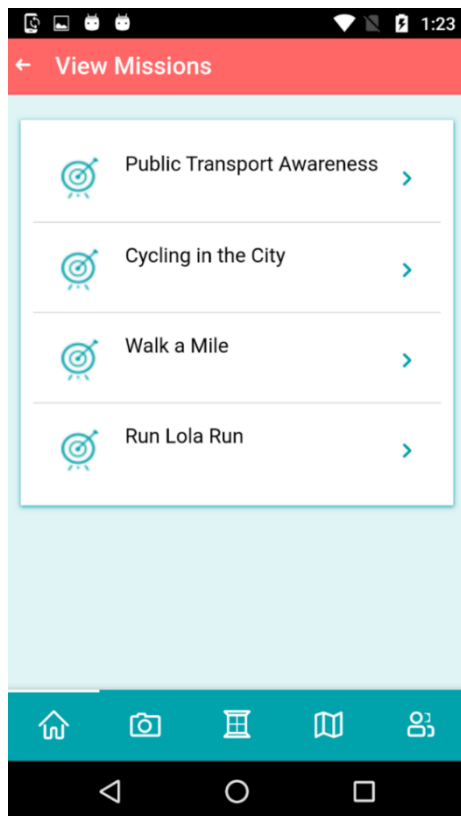


Figure 14 – Overview of gamification missions

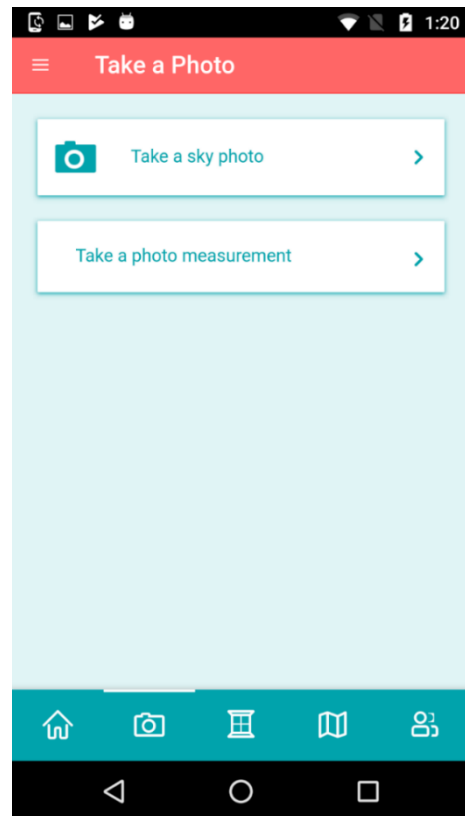


Figure 15 – Example of a specific mission

As stated the users can snap their own sky depicting photos and contribute to the overall calculation of the AQI of the area. Those photos reside under the user profile, as their personal contributions and take part in the AQI calculation at that given time in the specific place (Figure 16).

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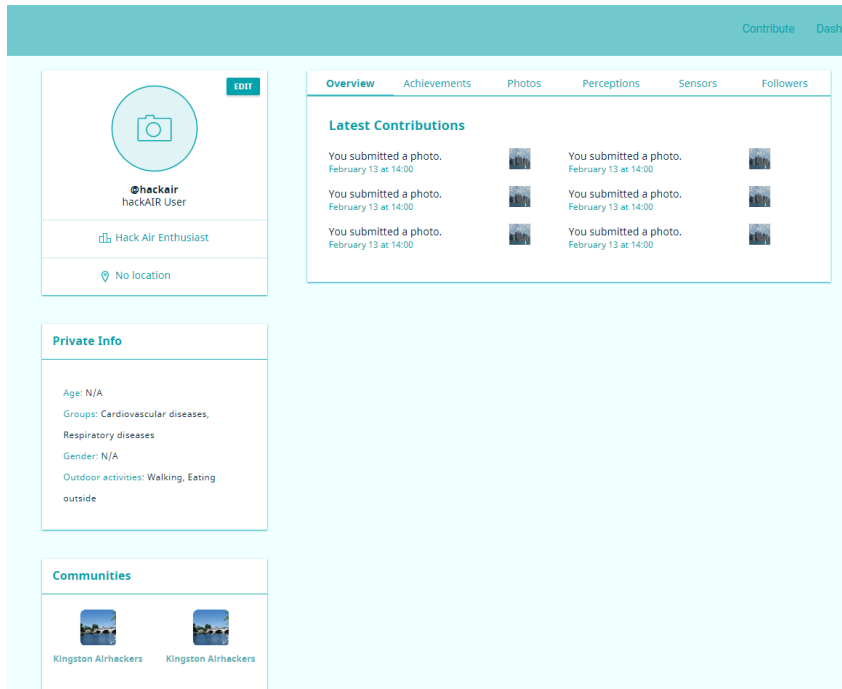


Figure 16 – List of sky depicting photos taken by a random user

Additionally, they can contribute by building a sensor system or simply adding readymade sensor systems which can measure pollutants and contribute constantly their data to the hackAIR platform (Figure 17).

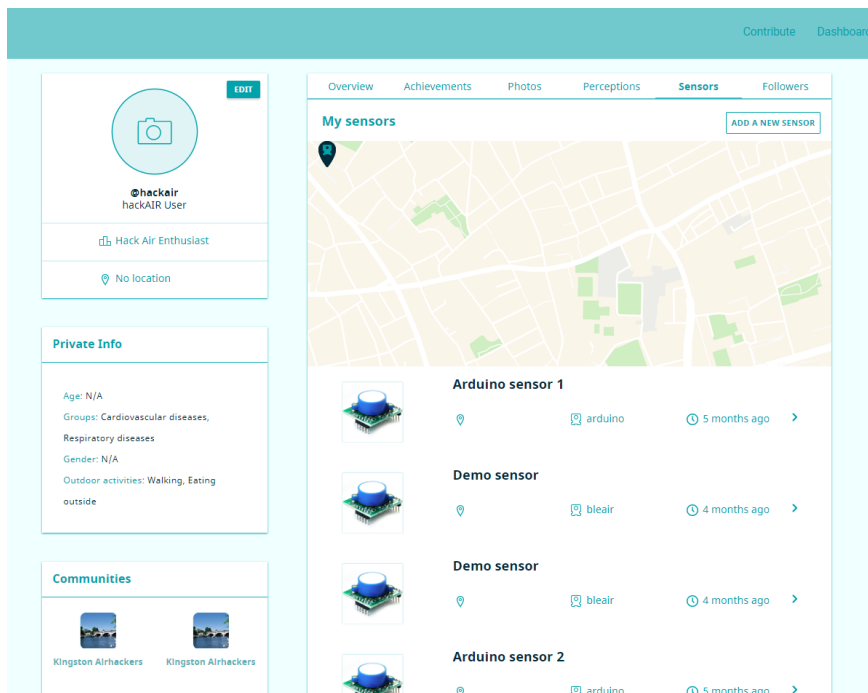


Figure 17 – List of sensors that a hackAIR user has setup

Lastly, one of the missions and functionalities available to the users, is completing their profile in order to get the essential information needed to supply them with personalized information regarding alerts and notifications affecting their everyday activities or the sensitivities they have. If specific conditions are met, the user gets notified via email and by push notifications (for the mobile application) of the hackAIR recommendations.

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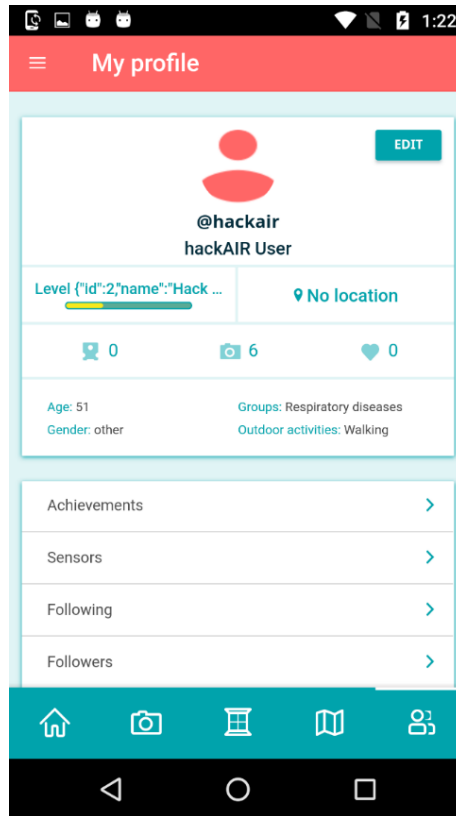


Figure 18 – User profile screen

All citizens using hackAIR can join any of the available communities, where they can contribute their measurements and assist their team to grow bigger and collect more data, while at the same time they contribute to the hackAIR platform. In addition, various social features (e.g. view other people's profile, add followers, invite friends, register/log in via social media etc) will enable users to link with and motivate each other to contribute to the community.

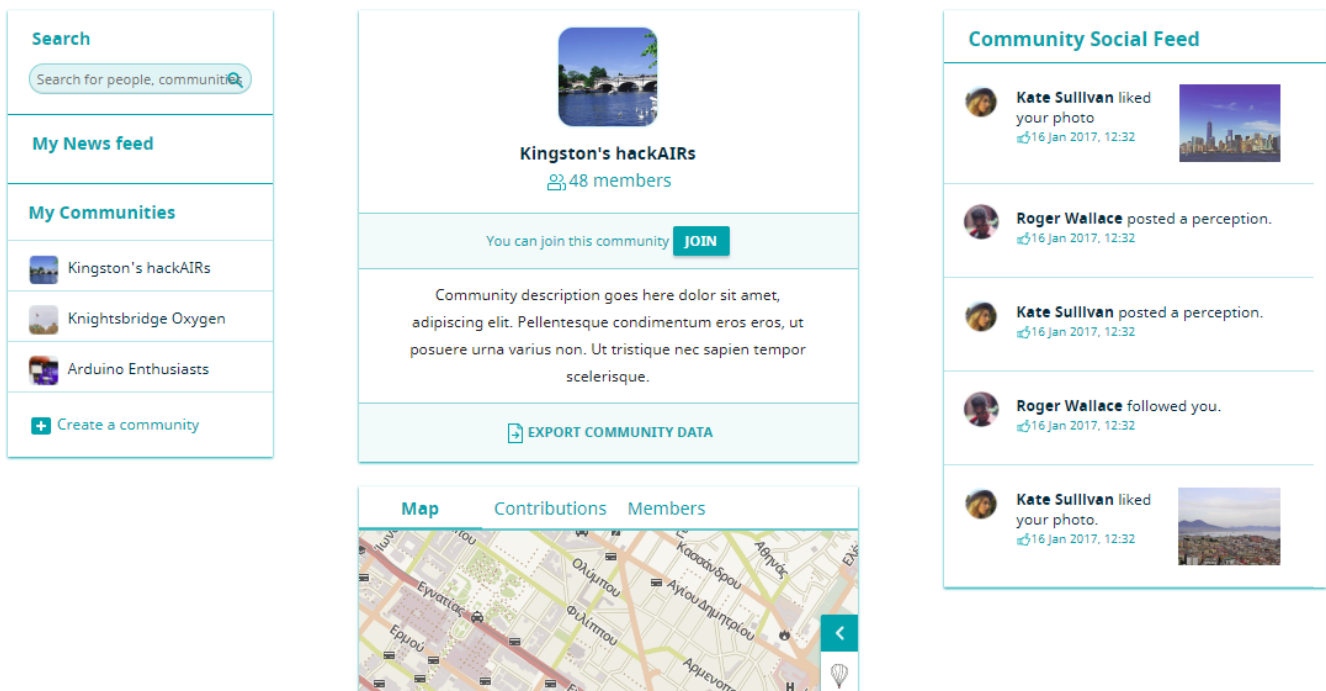


Figure 19 – Community home page

5 Conclusions

This document describes the progress made in WP5 toward building and delivering the 1st version of the hackAIR platform and its subcomponent. Provides some details on the changes compared to the previous deliverables that described the architecture, the implementation approach and lists the technologies that were used for the development of the platform. Furthermore, this document provides all the information of where to access the code, the documentation for the API and the actual deployed hackAIR platform.

There has been good progress in integrating and developing the rest of the features and the all targets have been reached. There are still minor features that are scheduled for the next two months but those mainly involve pages with informative text that will be of use to people outside the consortium who are not aware of the specifics of our platform. We consider the hackAIR application to be ready for the pilot operations and any feedback taken during this period will be evaluated and incorporated into our backlog to be delivered in the final deliverable of WP5, D5.3 (Final version of integrated and tested hackAIR open platform).

Appendix I - Gamification strategy

The gamification strategy was established with the help of an external consultant Oliver Simko from Luducrafts (www.luducrafts.com) and a gamification expert who is also a member of the hackAIR advisory board Mr Stavros Lounis. At some parts of the strategy, Mr Lounis states his personal opinions as feedback to the strategy.

In the present part of the gamification strategy the introduction of the users to the application also includes the onboarding process. It is suggested to have that as distinct phases of (a) getting the users on board, (b) having the user repeatedly return [2,3] and (c) Try to re-engage the user in case of leaving the app for some time. On that extent, the strategy could be analyzed in the following phases:

1. Onboard Users
 - a. Introduce users to the hackAIR application.
 - b. Provide onboarding process for Interface, Functionalities, Process of Gameplay, Advanced functionalities
2. AQ Gameplay
 - a. Obtain information about AQ in the users' surroundings
3. Raise Awareness and act on AQ
 - a. Strengthen the commitment of improving AQ on users' surroundings
 - b. Provide tips of how to improve the users' health in relation to AQ
 - c. Engage users' friends to join and become members
4. Re-engage inactive users
 - a. Utilize push notification and later e-mail (or Social Media) to reengage the inactive users (for example by providing a mission that is inactive for as long as a user is active but gets triggered after a pre-set period. This could have higher incentives than regular missions.)

User workflow

- **Introduce users to Hack Air application**

At this stage, users have limited information about hackAIR and need to understand the basic concept of the app. This could be done by a strong claim that sets up the narrative for the whole application like:

"Welcome to Hack Air. A place where you can measure and help to improve air quality! Join our community of hackers and let's beat air pollution together!"

In this simple statement, the mission is communicated and users are empowered with a sense of doing a meaningful action. Similar claims can be used in the overall hackAIR slang.

- **Onboarding process**

During this phase, the introduction of the core functions of the application needs to take place and provide a "quick-win" for the users, by demonstrating the added value. During the onboarding, users should be able to see a progress bar with their current level. When the onboarding finishes, the user first gets a reward either a new achievement (e.g. "Air enthusiast") or a new level (e.g. "Promising Air Hacker") or the newbie badge. The aim is to supply recognition and positive feedback along with a sense of completion. Onboarding should be built on manageable missions, that allows users to directly interact and use the hackAIR app.

- **Build habit of checking out the AQ and use of Hack Air**

Once the user signs up, the habit needs to be established, which can be established by following two user flows:

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- **Push notifications:**

Alerting users when the AQ is bad or notify them when the AQ is very good through push notifications e.g. “Avoid outdoor sport activities”, “Try to use public transport instead of car”, “If you have to use car, try to share it with other passengers”, “Try to turn off any unnecessary, energy consuming devices” or “Exercise outside”, “Ride a bike”. The actual messages should be more extend in two different directions (a) for the same push message to use more than one phrasing so that users do not constantly see the same message and (b) to have as many as possible suggestions to interchange.

As this is the main hackAIR-to-user triggering action, it is suggested to be used in a manner that does not make the user feel constantly nudged. It is suggested to utilize best practices or academic sources to determine the rate of communication. E.g. it was found that ill-timed notifications can lead to negative effect of a user’s emotional state and social attribution¹⁵ or psycho-physiological states¹⁶.

- **Daily missions:**

These should be a list of daily recommended activities, that can be viewed on the dashboard. Each day, users have a chance to complete quick missions and read suggestions they could do help reduce air pollution. Therefore, missions could be divided in to the “Mission of the day” which try to give users sense of empowerment and the “Tip for the day” which try to give added value and serve as a trigger for change in behavior. As missions are built on variables that lead to the accumulation of points it should be considered the ones that can be validated and the ones that are based on user’s feedback. For example, “Upload data” is an action that can be validated by the app whereas “Mean of transport e.g. take the bus vs take the car” or a “Predefined indoor/outdoor activity” is probably based on the users’ statement.

Missions can be built on these variables:

1. Allow to share location
2. Predefined indoor activities
3. Predefined outdoor activities
4. Means of transport
5. Upload data
6. Share AQ data and recommendations
7. Submit your feeling
8. Invite a friend to start using hackAIR
9. Post a question
10. Answer a question
11. Like an answer/question

Mission consists from:

- **Call to action - “Do something”.**
- **Description - “This is what you have to do”.**
- **Explanation - “Why is it important?”**
- **Score (internal) - How many points do you get**

In terms of mission composition and meta-information each mission could be represented additionally by:

¹⁵ P.D. Adamczyk, B.P. Bailey, If not now, when?: the effects of interruption at different moments within task execution, in: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, 2004, pp. 271–278.

¹⁶ J.G. Kreifeldt, M.E. McCarthy, Interruption as a test of the user-computer interface, in: JPL Proceeding of the 17th Annual Conference on Manual Control, 1981, pp. 655–667

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- status (Available / Unavailable / Completed / Ongoing / Failed)
- duration time (Open/Timeframed/Goalframed/Combined)
- play type (Single or Team¹⁷ based)
- reward type (Points / Badges / perhaps monetary etc.)

Missions

For the present (and additional game mechanics) it is suggested to also introduce the fail-case scenario. For example, a user is given feedback when something gets completed, but no feedback & action trigger takes place when the user fails (or fails based on when (s)he was supposed to succeed). When the mission is active and ongoing however the user faces problems completing it. Additionally, as hackAIR has both a desktop and mobile app, there could be specific missions to be played through the desktop version and others through the mobile. Not all, but to also have “extra” reasons (and added value) for both.

Name	Call to action	Description	Explanation	Feedback	Points	Feedback from the gamification expert of the Advisory Group
Mission to enter your profile details						This can be the first after the onboarding to direct the user to complete her/his profile. This could give a significant amount of points that would take the user to the next status level (should you introduce a newbie status level).
Quest for clean lungs	Search for fresh air	Try to visit areas, with low levels of air pollution. Take a look on the map and see if you can spot some!	Staying in areas with good AQ brings benefits to your health	Great! Take a deep breath and enjoy clean air!	400	How many areas should a user visit and what is the duration (s)he must stay in the place? This mission needs a success triggering rule.
Keeping it in check	Upload photo from location	Upload at least a photo of the sky from any location you want.	Build the habit of watching the sky - your data help others.	Thanks to your photo, we all get improved AQ data!	200	This seems as one of the main goals of the project and the base scenario of contribution, so it can be an ongoing mission which is open always.
Home base	Upload at least one photo from your home town.	Take and upload a photo of your home town.	It's important to have access and overview of AQ in your home area.	Thanks to this contribution, you will get a clear picture about the air you breathe near your home!	200	Does this cascade to the previous and the following? If so it leads to a high rate of getting points if not then it creates a problem that the user indeed uploaded a photo and was on her/his home base ergo eligible to receive points.

¹⁷ Will there be Team Based missions? Missions that can be played by more than one participants (e.g. a neighborhood)

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Where we all sleep.	Upload photo from habituated location	Take and upload a photo of the sky from the suburbs of s city.	Discover AQ in suburban areas is crucial for our research.	Thanks to your data, we all can plan and take decisions on our daily activities.	300	Does this cascade to the previous two? Same as above.
Investigate places of relax	Upload photo from location used for recreation (parks)	Take and upload a photo of the sky from a popular area used for outdoor activities and relaxation (parks).	It's important to measure air pollution in places where most people exercise or spend their free time.	Your contribution helps us to make sure that this area's AQ is fit for active lifestyle.	400	Very good mission
Taste the city's air	Upload photo from highly populated location	Take and upload a photo of the sky from the city centre.	AQ in cities is often at lower levels. The more data we have, the more accurate our recommendations can be.	Thanks to your contribution, other users can see which areas are most polluted in the city.	300	Very good mission
Searching for golden ticket	Upload photo from location where you think is the best air	Take and upload a photo of the sky from a place that you think have the purest air in your area.	You might lead us to unexplored territories! Yey, lead on!	By discovering and recommending areas with great AQ, you help others to find places to relax.	500	This may lead the user to explore the map for the location of the highest AQ currently and close to her/him and go there to upload a photo to get the points.
For the bravest!	Upload photo from location where you think is the worst air	Take and upload a photo of the sky from a place that you think has the worst AQ.	Let's warn others about these places!	By pointing places with low air quality, others might change their plans enjoy more fresh air.	500	Same as previous, in the other direction.
A monthly report!	Share AQ information with your friends and let them know the quality of the air they breathe.	Share a status about AQ on your social media feed.	Make sure others understand the importance of clean air in their life.	Thanks for spreading the word out. You never know...for someone your status might be an eyeopener.	100	Is this to be conducted on a monthly basis? Or a daily mission? Should the user opt to share her/his AQ info in shorter timeframes? This too could be an ongoing open mission.
Be a helping hand!	Share AQ data and recommendations	Upload your pollution data from your tracking device.	If you have built a sensor for air pollution monitoring, share your findings with others.	Mapping the trends is a fuel to our cause. Thank you for those!	200	This seems as one of the main goals of the project like the "Keeping it in check" however more difficult as it requires the sensors. So the effect of doing so illustrate a user with a higher vested interest. Consider having it as an open ongoing mission.

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You're not alone	Submit your feeling	Submit your perception of AQ on our scale.	It's important to know how other people perceive the AQ in your area..	Thank you! We think that sharing your feeling is a crucial thing!	100	Very good mission.
Hackers force	Invite a friend to start using hackAIR	Invite your friends via social media or e-mail.	The more hackers are out there, the stronger we are.	Thank you for supporting our cause with all your heart!	300	Very good mission. In case the users action lead to a new user registration then a second reward could be in place as it is very important.
Break the silence	Post a question	Go to web app's forum and submit a question about AQ	Discussion is an important part of any innovation.	Thank you for contributing to our community with your voice!	300	This should have a cooldown period as the user may opt to just post every day for the sake of receiving the points.
Wisdom bearer	Answer a question	Go to forum and answer any question.	Helping others is one of the most valuable things a hacker can do!	Thank you for contributing to our community with your opinions and wisdom!	300	This should have a cooldown period as the user may opt to just post every day for the sake of receiving the points.
Show a respect!	Like an answer/question	Go to forum and like questions or answers that you want to support.	Show respect to others by liking their answers or questions.	Showing support might encourage others to post their own stories!	100	This should have a cooldown period as the user may opt to just post for the sake of receiving the points. Additionally, as the missions upon completion are available again the next day a user is limited to liking something only once per day.

Badges

Badges representing achievements by the use of the hackAIR platform. Users can gain badges by completing missions or by meeting other "hidden" requirements (e.g.regular logging in). Badges should transparently communicate generated impact and should be awarded based on variables, presented in the table below.

Each badge should have:

1. Title
2. Picture
3. Flavour text that helps understand how this badge could be unlocked
4. Educative value - explanatory text of how each badge represent concrete impact that user generated.
5. The ability for the user to showcase her/his earned badges.

To enable that a badge should also include (a) functionality to show or hide the badge from the public profile (b) Per badge an additional descriptive text for public display (c) Per badge an additional text that showcases the achievement¹⁸ for private user display and (d) Consider levels within badges to mark shortmid- and long-term achievements (e.g. Log In Badge #1 White=3 consecutive days, Silver=10 consecutive days, Gold=20 consecutive days and Platinum = 50 consecutive days. The latter suggestion can be applicable for most badges.

¹⁸ For example, the instruction of badge #1 is after what has been done where in badge #3 it is instruction to do.

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Variable	Exemp. Badge	Title	Instructions	Educative value	Feedback from the gamification expert of the Advisory Group
How long the user is logged in	1 hour of hacking the Air	Feels like home!	You have spent 1 hour in the app.	The longer your review, study or upload data, the better is final outcome.	The title of the badge could be changed to clearly showcase what the user achieved. Instruction is positioned after the reception of badge
No. of logins in the last x days	3 days in a row	Hackathon	You have logged three days in a row!	By checking out AQ on a regular basis, you receive information that helps you to make better decisions and plan ahead.	Title misalignment and also why is 3 days in a row considered eligible for a badge? How about 5/10/etc.? Instruction is positioned after the reception of badge
Health group (allergy, cardiovascular and respiratory diseases, pregnant)	A health watcher!	A health watcher!	In profile settings, mark what type of health group you are in.	More concrete data allows us to work on more elaborate strategies and public calls.	---
Location	Fresh air hunter	Fresh air hunter	Visit locations with low index of air pollution	More time spent in these area means healthier life for you.	This dependent of the data you will receive might be an easy badge for some and a very difficult badge for others. This needs to be normalized based on the effort required by different individuals. This needs triggering rule. For example how many new locations are required to be eligible for the badge?
Sensor measurements	Keep it scientific. +set up sensor +upload data	Keep it scientific.	Review and share data from sensor measurements	Don't count just on your feelings. Make your decisions built on rock solid base.	Review and Share are two different actions and perhaps should be considered separately. Additionally, on how many reviews and/or shares is the user eligible to be awarded the badge?
Questions and answers	Share with others	Share with others	Post a question or a reply on our community forum in web app.	When people collaborate, it creates 2+2 equals 5 effect.	This is a very important part which could merit separation into (a) post questions and (b) post replies. Two different badges could trigger different types of engagement
Number of photos uploaded per day	Watcher on the wall	Watcher on the wall!	Upload 5 different photos	More data means more accurate feedback for us.	Number of photos can be extended into the previous proposed leveling within badges.

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Number of sensors installed	hackAIR's hero	hackAIR's hero	Install at least 3 sensors.	More data means more accurate measurement.	Here you can have a plethora of badges based on number
Number of measurements per day	Prolific hacker	Prolific hacker	Measure and upload at least 1 photo today.	The more data we collect, the stronger our claims and public calls may be.	If the data is continuous monitored but the upload is user decided, then it could be on the upload.
User lives in polluted areas	A survivor	A survivor	Take photo / measurement at the same place at least 3 days in a row. If all measurements show bad AQ, you will receive this badge	The odds may be against you for now, but still, you want to fight for a better future.	This badge has a negative positioning towards the state the user is in.
Add sensor	Install at least 1 sensor.	A hacker's masterpiece	Install at least 1 sensor.	Even one sensor may help to get realistic bigger picture.	This could be extended based on the optimal number of sensors each user would ideally install if it was up to you. So, the masterpiece would go to the "fully fledged" version.
Update sensor location	Constantly on the move	Constantly on the move	Move sensor to a different area.		This needs triggering rule. For example, at which milestone is it "unlocked"?
Share AQ and recommendations	Beacon in the dark	Beacon in the dark	Share your data and findings with others	By sharing, you raise awareness and help to spread the word!	The user can opt to share the data with the system as well as with other users? In any case this also needs triggering rule.
Submit your feeling	How is your life today?	How is your life today?	Submit how you feel today on our barometer.	Your subjective perception is as important as objective measurements.	This needs triggering rule. For example, at how many feeling submissions is it "unlocked"?
Check historical data (choose 10 days or 10 months from the graph)	History buff	History buff	Check historical data going back to 10 days.	Seeing the bigger picture allows you to make smart decisions.	This could be split into two (days/months) or even better to introduce a milestone (e.g. do that 10 times)
Invite a friend to start using hackAIR	Helping hand	Helping hand	Invite a friend so you can hack the air together.	The bigger our community is, the bigger impact we may produce.	Probably this would be validated with the use of deeplinks? or a referral code so that you can see that the action of a new user register is connected to the invitation from a user. Either way this is crucial to be rewarded in many levels up to the degree

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					of an “Evangelist” of the Hack Air
Uploaded photos based on location		Hacker nomad	Upload photos from at least 5 different locations.	Taking measurements in different areas helps us compare data more precisely.	This could have different versions of the badge as well.

Levels

Generally, a level is defined as a set of “Increasingly difficult environments”¹⁹ where different types of difficulty (e.g. easy, medium, hard) is used to separate different bundles of actions required within the game space.

Relative to levels are Status Levels that users achieve based on the accumulation of points. This Status level structure goes an upwards trajectory with different names per Status Level (Enthusiast, Serious fighter, Hero, ... etc). The amount of points required should reflect the effort necessary to be achieved based on the actions that are deemed eligible to reward points.

Proposed levels:

1. Hack Air Enthusiasts (0-100 points)
2. Hack Air Serious fighter (300 points)
3. Hack Air Police officer (600 points)
4. Hack Air Agent (1000 points)
5. Hack Air Prodigy (4000 points)
6. Hack Air Mastermind (9 000 points)
7. Hack Air Elite (15 000 points)
8. Hack Air Inspector (25 000 points)
9. Hack Air Elite Hacker (50 000 points)
10. Hack Air Hero (100 000 points)

Role Play Scenarios

Overall the concept of becoming an AQ Hacker (or AQ Superhero or anything similar) can serve as a grounded concept where a user can receive a main persona or a role within the whole concept. This can be directed by either badges or specific missions. For example, if a specific user is at a place where X particle is identified the (s)he gets to constantly inform on that particle and be enabled to receive respective badges. So, to use the analysis results found in different places as level or progress guiding elements in the game itself.

¹⁹ Katie Seaborn, Deborah I. Fels, Gamification in theory and action: A survey, International Journal of Human-Computer Studies, Volume 74, February 2015, Pages 14-31, ISSN 1071-5819, <http://doi.org/10.1016/j.ijhcs.2014.09.006>.

Indicative onboarding text for narration:

1. Welcome to Hack Air!

Looks like we have a new fighter for better air. Hope you'll feel like home here! Take a deep breath and let's start cleaning the air.

2. Let's set up your account, shall we?

As a hacker, you need a home base from which you can operate. This should be your profile where you can see all the important data. Let's set it up!

3. Now that you've created your account, let's dive into action!

Your role is to search for clean air in your area and report any areas with low air quality you find. Your results help other hackers and serves as a basis for further research.

4. Roll up your sleeves and let's start hacking

Millions are waiting for your help. Let's start with your first mission. Missions are small tasks that help us fight the air pollution together. Click on the Mission icon to start.

5. Your first mission!

Great! Read and follow mission's instructions. When complete, you'll help the community and progress on your journey of hacking the air.

6. Great! That was a blast!

Now, you can visit the mission list for all available missions. You can carry out as many as you like. Each mission can be repeated once per week.

7. Meet other heroes

If you want to raise the bar, visit forum on our web and help other hackers in their journey, if you feel like. For contribution, you must turn your profile as public in the settings.

8. Don't forget to be proud on your work!

One small step at the time can do miracles. To see your achievements and contribution, visit your profile or scroll through the achievement screens.

Tips of the day

hackAIR aims to provide to the user a *tip of the day*, meaning useful daily advice on how to improve the ambient air quality, to reduce air pollution or to limit their exposure to air pollution. Below, is a list of all suggested tips of the day, from which the hackAIR platform will select and present a random one every time the user requests for such feedback:

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1. You could reduce emitted air pollutants if moving by public means of transports.
2. Bike or walk to close destinations. Keep in shape while saving planet!
3. Transportation accounts for about 23% of greenhouse gas emissions in Europe. Walk or cycle instead of driving or using a motor vehicle.
4. Carpool to work. It makes traffic jams less annoying!
5. Driving slowly on unpaved roads can prevent vehicles from kicking up dust.
6. Don't idle! Switch off the motor of your car sitting still for longer than 10 seconds.
7. To warm up your car, drive slowly the first 5km instead of run. Gentle ride means gentle pollution!
8. Keep your car engine in good condition by performing the regular maintenance.
9. Avoid aggressive driving while traveling and reduce toxic emissions by 5 times!
10. Drive at 120km/h in the highway. You'll use less fuel and produce less emissions.
11. Set your thermostat no higher than 20°C during the day, and turn it down when you're out or asleep.
12. Prefer to use energy efficient light bulbs and appliances. Making impact, one bulb at a time!
13. Keep your water heater at 50°C, and use cold water whenever possible. Helps you to stay sharp!
14. Switch off the lights when you are not in the room. The room is not afraid of dark...
15. Unplug electronic devices when not in use. They'll thank you later!
16. Use fans instead of air conditioner.
17. Limit the use of your wood stove. Except you want to melt iron...in that case... fire on!
18. Don't burn wet wood. It's like eating frozen vegetables... No one enjoys it.
19. If you have to burn wood in your home, follow useful precautions to reduce pollution.
20. Don't burn wood that is painted. It won't colour the steam, only produce more pollution.
21. Don't burn your garbage. If you burn it, dumpsters will starve!
22. Avoid the use of spray products. That smells of... CO₂.
23. Avoid garden tools that run on gasoline. Approved by flowers of all kind.
24. Did you know that a family of four members is responsible for releasing 20 tons of greenhouse gases into the atmosphere each year?
25. Energy consumption in home is the 3rd source after transportation and industry. Reduce your ecological footprint: close heating vents and doors to rooms that you are not using.
26. Hang clothes out in order to dry instead of using a dryer.
27. Avoid burning organic waste or garden leftovers. Prefer to compost them!
28. Put some plants in your home, or even plant trees in your garden. Trees and plants help purify the air.
29. Use natural soy or beeswax candles instead of petroleum/paraffin-based candles.
30. Avoid BBQ when air pollution levels are high. Steak can wait. Planet cannot.
31. Recycle as much as you can! Buy products that do not have a lot of packing and that can be recycled.
32. Don't do sports outdoors during rush-hour traffic.
33. Avoid arterial roads when staying outdoors.
34. Exercise outdoors early in the morning, to avoid rush-hour air pollution.
35. Use video conferencing for business meeting, when possible, in order to avoid unnecessary travel.
36. Use the hackAIR app to avoid air pollution hotspots.
37. Try to eat fresh fruits and vegetables. They help maintain your body's antioxidant reserves which are able to reduce the effects of air pollution.
38. Keep windows closed when outdoor air pollution is high.
39. If cooking with gas, use an extractor fan with a filter.

Appendix II - hackAIR Testing Scenarios

The complete list of the scenarios which were created for hackAIR is presented in this appendix. Those tests were followed upon new feature deployment (during development) and some were executed manually by humans and some automatically written in code. The information provided for each are:

Test Steps: The steps needed to follow this test

Expected results: Where should the platform or the mobile navigation take the user upon successful completion

Actual results: The results of the latest run test

Fail Cases: The scenarios which trigger validations or the test mission to fail

Testing Date: When was, the test followed the last time

Completion: If the test was successful the last time

Automated: If the test is manual or automated (automated tests do not usually execute manually)

Test Scenario: Login Web

Test Steps:

- Navigate to <http://hackair.draxis.gr/>
- Click Login
- Fill email
- Fill password
- Click Login button

Expected results:

Dashboard Page

Actual results:

Dashboard Page

Fail Cases:

- Leave email blank (error message explaining why login failed)
- Leave password blank (error message explaining why login failed)

Completion: Done

Automated: Yes

Test Scenario: Login Mobile

Test Steps:

- Open hackAIR app
- Navigate to login screen
- Fill email
- Fill password
- Click login button

Expected results:

Dashboard Page

Actual results:

Dashboard Page

Fail Cases:

- Leave email blank (error message explaining why login failed)
- Leave password blank (error message explaining why login failed)

Completion: Done

Automated: No

Test Scenario: Registration Web

Test Steps:



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- Navigate to <http://hackair.draxis.gr/register>
- Fill username
- Fill email
- Fill password
- Fill repeat password
- Click submit button

Expected results:

Confirmation email

Actual results:

Fail Cases:

- Leave username blank (validation error)
- Use already existing username (error message explaining why registration failed)
- Leave email blank (validation error)
- Use already existing email (error message explaining why registration failed)
- Leave password blank (validation error)
- No matching passwords (validation error)

Testing Date: 10/7/2017

Automated: Yes

Test Scenario: Registration Mobile

Test Steps:

- Open hackAIR app
- Navigate to registration screen
- Fill username
- Fill email
- Fill password
- Fill repeat password
- Click submit button

Expected results:

Collector shows up for approval on linked company page

Actual results:

Collector showed up for approval on linked company page

Fail Cases:

- Leave username blank (validation error)
- Use already existing username (error message explaining why registration failed)
- Leave email blank (validation error)
- Use already existing email (error message explaining why registration failed)
- Leave password blank (validation error)
- No matching passwords (validation error)

Completion: Done

Automated: No

Test Scenario: City Choice Web

Test Steps:

- Navigate to <http://hackair.draxis.gr/>
- Click Login
- Fill email
- Fill password
- Click Login button
- From the dropdown on the center of the page select a city

Expected results:



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Map of the chosen city and an infobox on the left side of the page

Actual results:

Map of the chosen city and an infobox on the left side of the page

Fail Cases:

Completion: Done

Automated: Yes

Test Scenario: City Choice Mobile

Test Steps:

- Open hackAIR app
- Navigate to login screen
- Fill email
- Fill password
- Click login button
- Click on map screen
- Write the name of the city you want to search
- (Optional) Click on the suggested name showing up via auto-complete

Expected results:

Map of the chosen city

Actual results:

Map of the chosen city but only the second time trying to do so, the first it's a random place

(11/7/2017)

Fail Cases:

Testing Date: 11/7/2017

Completion: Failed

Automated: No

Test Scenario: Add Profile Information Web

Test Steps:

- Navigate to <http://hackair.draxis.gr/>
- Click Login
- Fill email
- Fill password
- Click Login button
- Click on your username on the upper right corner and click Profile
- Click edit on the left hand panel
- Add necessary information (name, surname, location, year of birth, gender, particular sensitivities, outdoor activities)
- Click save

Expected results:

Details shown on left hand panel

Actual results:

Details shown on left hand panel

Fail Cases:

Completion: Done

Automated: Yes

Test Scenario: Add Profile Information Mobile

Test Steps:

- Open hackAIR app



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- Navigate to login screen
- Fill email
- Fill password
- Click Login button
- Navigate to profile screen
- Click edit
- Add necessary information (name, surname, location, year of birth, gender, particular sensitivities, outdoor activities)
- Click save

Expected results:

Details shown on profile screen

Actual results:

Details shown on profile screen

Fail Cases:

Completion: Done

Automated: No

Test Scenario: Share AQ on Facebook Web

Test Steps:

- Navigate to <http://hackair.draxis.gr/>
- Click Login
- Fill email
- Fill password
- Click Login button
- Choose a city from the dropdown menu in the center of the map
- Click the share button on the infobox on the left side of the screen
- Click the facebook share button on the popup that appears
- (Optional) Write a personal comment
- Click post to facebook

Expected results:

New post on facebook

Actual results:

New post on facebook

Fail Cases:

Completion: Done

Automated: No

Test Scenario: Share AQ on Facebook Mobile

Test Steps:

- Open hackAIR app
- Navigate to login screen
- Fill email
- Fill password
- Click Login button
- Search for a city on the dashboard screen
- Click the share button
- Click the facebook share button
- ...

Expected results:

New post on facebook

Actual results:



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New post on facebook

Fail Cases:

Completion: Done

Automated: No

Test Scenario: Share AQ on Twitter Web

Test Steps:

- Navigate to <http://hackair.draxis.gr/>
- Click Login
- Fill email
- Fill password
- Click Login button
- Choose a city from the dropdown menu in the center of the map
- Click the share button on the infobox on the left side of the screen
- Click the twitter share button on the popup that appears
- (Optional) Write a personal comment
- Click tweet

Expected results:

New tweet on twitter

Actual results:

New tweet on twitter

Fail Cases:

Completion: Done

Automated: No

Test Scenario: Share AQ on Twitter Mobile

Test Steps:

- Open hackAIR app
- Navigate to login screen
- Fill email
- Fill password
- Click Login button
- Search for a city on the dashboard screen
- Click the share button
- Click the twitter share button
- Write a tweet
- Complete phone/email/username and password for twitter account
- Click login and tweet

Expected results:

New tweet on twitter

Actual results:

New tweet on twitter

Fail Cases:

Completion: Done

Automated: No

Test Scenario: Fusion Map Web

Test Steps:

- Navigate to <http://hackair.draxis.gr/>
- Click Login



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- Fill email
- Fill password
- Click Login button
- From the dropdown in the center of the screen choose a city
- From the filters on the right side of the screen click the fusion map icon

Expected results:

Color overlay on map according to the air quality index of the area

Actual results:

Color overlay on map according to the air quality index of the area

Fail Cases:

Completion: Done

Automated: No

Test Scenario: Fusion Map Mobile

Test Steps:

- Open hackAIR app
- Navigate to login screen
- Fill email
- Fill password
- Click Login button
- Navigate to map screen
- Search for a city on the map screen
- From the filters on the right side of the screen click the fusion map icon

Expected results:

Color overlay on map according to the air quality index of the area

Actual results:

Color overlay on map according to the air quality index of the area

Fail Cases:

Completion: Done

Automated: No

Test Scenario: Map Filters Web

Test Steps:

- Navigate to <http://hackair.draxis.gr/>
- Click Login
- Fill email
- Fill password
- Click Login button
- From the dropdown in the center of the screen choose a city
- From the filters on the right side of the screen click the filter you want to test

Expected results:

Icons show up on the map according to the chosen filter

Actual results:

Icons show up on the map according to the chosen filter

Fail Cases:

Completion: Done

Automated: No

Test Scenario: Map Filters Mobile

Test Steps:



D5.2: 1st version of integrated and tested hackAIR open platform

- Open hackAIR app
- Navigate to login screen
- Fill email
- Fill password
- Click Login button
- Navigate to map screen
- Search for a city on the map screen
- From the filters on the right side of the screen click the filter you want to test

Expected results:

Icons show up on the map according to the chosen filter

Actual results:

Icons show up on the map according to the chosen filter

Fail Cases:

Completion: Done

Test Scenario: Add New Sensor Web

Test Steps:

- Navigate to <http://hackair.draxis.gr/>
- Click Login
- Fill email
- Fill password
- Click Login button
- Click on the username/name on the upper right corner
- Click Profile
- Click on the sensors tab
- Click add a new sensor
- Fill out the sensor name
- Click on the click button next to the location field
- Choose a location on the map
- Click save sensor location
- Choose a sensor type from the dropdown menu
- Click save

Expected results:

New sensor showing up on the sensors tab

Actual results:

New sensor showing up on the sensors tab

Fail Cases:

Completion: Done

Automated: No

Test Scenario: Add New Sensor Mobile

Test Steps:

- Open hackAIR app
- Navigate to login screen
- Fill email
- Fill password
- Click Login button
- Navigate to the profile screen
- Click on the sensors tab
- Click add a new sensor
- Fill out the sensor name

D5.2: 1st version of integrated and tested hackAIR open platform

- Fill out the location of the sensor
- Choose a sensor type from the dropdown menu
- Fill out the MAC address of the sensor
- Click save

Expected results:

New sensor showing up on the sensors tab

Actual results:

New sensor showing up on the sensors tab

Fail Cases:

Completion: Done

Automated: No

Test Scenario: Map Pop-Ups Web

Test Steps:

- Navigate to <http://hackair.draxis.gr/>
- Click Login
- Fill email
- Fill password
- Click Login button
- Wait for the map to load
- Click on an icon (image/sensor)

Expected results:

Information about the image/sensor

Actual results:

Information about the image/sensor

Fail Cases:

Completion: Done

Automated: No

Test Scenario: Map Pop-Ups Mobile

Test Steps:

- Open hackAIR app
- Navigate to login screen
- Fill email
- Fill password
- Click Login button
- Navigate to the map screen
- Search for a city
- Wait for the map to load
- Click on an icon (image/sensor)

Expected results:

Information about the image/sensor

Actual results:

Information about the image/sensor

Fail Cases:

Completion: Done

Automated: No

Test Scenario: Missions Web

Test Steps:

- Navigate to <http://hackair.draxis.gr/>
- Click Login
- Fill email
- Fill password
- Click Login button
- From the dropdown in the center of the screen choose a city
- Below the infobox on the left hand side of the screen click on the missions arrow

Expected results:

A new screen showing available missions

Actual results:

A new screen showing available missions

Fail Cases:

Completion: Done

Automated: No

Test Scenario: Missions Mobile

Test Steps:

- Open hackAIR app
- Navigate to login screen
- Fill email
- Fill password
- Click Login button
- On the dashboard screen click on the missions arrow

Expected results:

A new screen showing available missions

Actual results:

A new screen showing available missions

Fail Cases:

Completion: Done

Automated: No

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