## Title:

D4.3 Deployment of ENTROPY Serious Games

## Document Version:

3.0

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** Abstract:**

This document describes the components of the serious games AR Treasure Hunt demonstrator.

** Keywords:** Augmented Reality, serious game, gamification, energy efficiency
# Revision History

The following table describes the main changes done in the document since created.

<table>
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<th>Description</th>
<th>Author (Organization)</th>
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<td>Norma Zanetti (HYPER), Dimosthenis Kotsopoulos (AUEBELTR)</td>
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Executive Summary

This document gives an overview of all required components to use the Entropy AR Treasure Hunt serious game mobile application, and web based creator which enables fast creation of each game. The mobile platform serious game was Beta tested and reported feedback from the users was utilized to further improve the game.

Disclaimer

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1. **INTRODUCTION**

The objective of ENTROPY is to steer user behaviour towards energy efficiency habits. The user should stay engaged with the personalized app and series of serious games through the constant motivation provided by personalized incentives, enabling him/her to view their progress toward personal or global goals.

The following sections give an overview of documents and procedures required to run the serious game Augmented Reality (AR) based Treasure Hunt mobile app (Android and iOS) and Treasure Hunt Creator demonstrators that will support ENTROPY pilot users’ decision making towards energy efficient behaviours, actions and lifestyle.
2. **AUGMENTED REALITY (AR) TREASURE HUNT SERIOUS GAME**

2.1 **Entropy AR Treasure Hunt Demonstrator**

AR Treasure Hunt serious games were developed for needs of ENTROPY project, and are available on project’s owncloud repository, on the following link: [http://owncloud.euprojects.net/owncloud/index.php/apps/files/?dir=%2Fentropy%2F05%2F20-WP5%2F20Pilots%2F05Orchestration%2FAR%2FARTreasure%2F20Hunt%2F20Beta](http://owncloud.euprojects.net/owncloud/index.php/apps/files/?dir=%2Fentropy%2F05%2F20-WP5%2F20Pilots%2F05Orchestration%2FAR%2FARTreasure%2F20Hunt%2F20Beta)

The following components are delivered in order to be able to fully deploy the software for pilot testing and implementation (see Figure 1):

1. AR Treasure Hunt User Manual
2. Software-Beta – AR Treasure Hunt application
3. Entropy Pilot Lookup Table
4. Markers
5. Validation QR code

![Figure 1: ENTROPY AR Treasure Hunt components for pilot deployment](image-url)
2.2 **AR Treasure Hunt User Manual**

AR Treasure Hunt mobile phone serious game User Manual can be found in Entropy project repository on the following link:


2.3 **AR Treasure Hunt Software**

AR Treasure Hunt game in .apk format is to be installed and used on Android devices, while download link via TestFlight will also be provided for iOS devices once the Android version is finalised.

README file keeps track of different versions of the software due to modifications implemented due to bug fixing, changes of data interfaces with ENTROPY platform and comments for users in Beta testing phase of the project.

2.4 **ENTROPY Pilots Lookup Table**

The example of Lookup table describes which markers will be used at different locations on Pilot sites (HESSO, UMU and POLO).

<table>
<thead>
<tr>
<th>Markers</th>
<th>Pilot Hesso</th>
<th>Pilot Umu</th>
<th>Pilot Polo</th>
</tr>
</thead>
<tbody>
<tr>
<td>LED</td>
<td>Polaris (meeting)</td>
<td>Lanave Room 1</td>
<td>Lotto1</td>
</tr>
<tr>
<td>Incandescent Light Bulb</td>
<td>Polaris (meeting)</td>
<td>Lanave Room 1</td>
<td>Lotto1</td>
</tr>
<tr>
<td>CFL</td>
<td>Polaris (meeting)</td>
<td>Lanave Room 1</td>
<td>Lotto1</td>
</tr>
<tr>
<td>Air-conditioning</td>
<td>Dude (office)</td>
<td>Lanave Room 2</td>
<td>Lotto2</td>
</tr>
<tr>
<td>CRT monitor</td>
<td>Dude (office)</td>
<td>Lanave Room 2</td>
<td>Lotto3</td>
</tr>
<tr>
<td>Solar panel</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marker mix CO2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marker mix Energy</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sensors</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Polaris</td>
<td>Luminosity, temperature, humidity, CO2, Location, Nb person, Door</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dude</td>
<td>Luminosity, Temperature, Humidity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sierre</td>
<td>Outside temperature</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lanave Room 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lanave Room 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lotto 1</td>
<td>Luminosity, temperature, humidity and CO2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lotto 2</td>
<td>Luminosity, temperature, humidity and CO2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lotto 3</td>
<td>Luminosity, temperature, humidity and CO2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Figure 2: ENTROPY Pilots Lookup Table with locations and AR markers*
2.5 Markers

The AR markers are placed at different locations on Pilot sites, and provide clues for different questions of AR Treasure Hunt. They also trigger visualisation of real sensor data at these locations. Examples of AR markers can be seen in the Table below.

*Table 1: Examples of AR Markers used for ENTROPY AR Treasure Hunt*
2.6 Testing of Entropy AR Treasure Hunt Mobile Application

2.6.1 Testing Process

The application testing has taken place by authorizing access to the mobile application to a restricted number of people for executing the beta test (Site Acceptance Testing), and the following steps were performed:

- Installation and distribution of app
- Document with mobile application installation, features and expected behavior was sent (User Manual)
- This group of people will report back the behavior of the app and will always take into consideration the corresponding features of the current version (v1.00).
- Reports of bugs will be investigated.
- Once bugs and comments are confirmed and accepted, they will be fixed and a new APK version will be created.
- Application testing and refinement: aims initially android mobile devices.

2.6.2 Reporting of Issues

The issues are reported by Pilot Campaign Managers via Entropy’s GitHub development platform (see Figure below).

![GitHub Issues](image)

*Figure 3: Reporting of Issues related to functioning of AR Treasure Hunt game*
2.6.3 Resolving Issues

The open issues are re-tested using Quality Assurance procedures. Consequently the following steps are done:

1) Bug fixing
2) UX/UI redesign
3) Code modifications

The following Figure illustrates some of the changes implemented to address users in Beta testing phase of the development.

Figure 4: AR TH game modification due to reported comments and issues
### 2.7 AR Treasure Hunt Mobile App Demo

This section gives an overview of the Entropy AR Treasure Hunt demo application screens, illustrating the core functionality that will be used with extended set of questions and recommendations. The demo of the game can be viewed on: [https://www.youtube.com/watch?v=ZaKxUu-6KyU&feature=youtu.be](https://www.youtube.com/watch?v=ZaKxUu-6KyU&feature=youtu.be)

<table>
<thead>
<tr>
<th>Welcome Screen with TH Goal/Challenge Available Prizes and Log In</th>
<th>TH Goal Screen Specified goal of current TH game</th>
<th>Log In Screen</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Welcome Screen" /></td>
<td><img src="image2.png" alt="TH Goal Screen" /></td>
<td><img src="image3.png" alt="Log In Screen" /></td>
</tr>
<tr>
<td><strong>Available Prizes</strong></td>
<td><strong>My Prizes</strong></td>
<td><strong>My Prizes</strong></td>
</tr>
<tr>
<td>Prizes to be won in the game</td>
<td>Prizes won in the TH game</td>
<td>can be validated through the AR TH app or sent to a friend</td>
</tr>
</tbody>
</table>

### Welcome Screen

- **Start**

- **Welcome to Treasure Hunt**
  - Take part in TH to learn how you can become more energy...
  - Be the one to collect the most points...

- **Available Prizes**
  - **Free Coffee**
  - **Mango** - 10% off
  - **H&M** - 50% off

### TH Goal Screen

- **Current game**
  - **Goal**
    - Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur.

### Log In Screen

- **Username or E-mail**
- **Password**
- **Login**
- **Facebook**
- **Google+**
  - **Already have an account? Login**
  - **Don’t have an account? Forget your password?**
  - **OR**

- **My Prizes**
  - **Used**
  - **Valid**
  - **Send to a friend**
Welcome Screen | TH Game Menu | Game History
---|---|---
![Welcome Screen](image1.png) | ![TH Game Menu](image2.png) | ![Game History](image3.png)

**AR step in TH Game**
Camera is ON, while player is looking to scan image marker. Camera OFF button is available to switch off the camera.

**AR step in TH Game**
Scan image marker to reveal a clue

**AR step in TH Game**
Scan image marker based on previous clue and win points

![AR step in TH Game](image4.png) ![AR step in TH Game](image5.png) ![AR step in TH Game](image6.png)

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HINTS
Use hints to solve the clue, but beware – the points will be lost.

MORE INFO
When you solve a clue you might learn something new!
<table>
<thead>
<tr>
<th>Multiple Choice Questions</th>
<th>Multiple Choice Questions</th>
<th>Multiple Choice Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>beware</strong> – points are lost if you choose wrong answer</td>
<td><strong>beware</strong> – points are lost if you choose wrong answer</td>
<td><strong>beware</strong> – points are lost if you choose wrong answer</td>
</tr>
</tbody>
</table>

**Multiple Choice Questions**

1. How is light bulb brightness measured?
   - Watts
   - Lumens
   - Joules
   - Footcandles

2. How is light bulb brightness measured?
   - Watts
   - Lumens
   - Joules
   - Footcandles

3. How is light bulb brightness measured?
   - Watts
   - Lumens
   - Joules
   - Footcandles

**Congratulations**

Treasure Hunt still in progress

00:05:03 to end

Congratulations Marcelo!

You are currently in 1st position. Please check scoreboard at the end of TH to discover if you won some prizes.

Score: 25€

**Play Again**
<table>
<thead>
<tr>
<th>My Actions</th>
<th>Active Actions</th>
<th>Active Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active, Done and Achievements</td>
<td>Based on Recommendations</td>
<td>Achievements – badges won</td>
</tr>
</tbody>
</table>

Real Time Data Visualization  
Personal Score  
Scoreboard

---

**Treasure Hunt Still in Progress**

<table>
<thead>
<tr>
<th>No.</th>
<th>Player</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Marcelo</td>
<td>355</td>
</tr>
</tbody>
</table>

Recommended indoor temperature in summer time is 23-26 °C
3. **AR TREASURE HUNT CREATOR**

3.1 **Introduction**

Treasure Hunt Creator is a web browser on-line tool which enables fast and simple creation and deployment of AR Treasure Hunts serious game using a 'drag&drop' concept which does not require programming skills. It is a cross-platform cloud-based service for building AR powered smartphone, tablet or desktop applications. The solution enables application execution on any desired platform: Android, iOS, Windows and Mac.

3.2 **AR Treasure Hunt Creator User Manual**

The user manual covers all required functionalities to create AR Treasure Hunt application for Android and iOS mobile platforms, namely:

- Operator’s registration, login and logout
- Creation of AR Treasure Hunt games
  - Defining game settings, such as
    - Point based or Time based Treasure Hunt games
    - Level of Difficulty for Point based TH games
    - Others
  - Two types of clue: AR and Q&A Questions
  - For AR content use of 2D models, 3D models and text
  - For AR markers use of images, GPS location and location
  - For AR controls use of shot, flash, info and web link button
  - For Q&A Questions two different types can be used:
    (i) Single Answer Question and
    (ii) Multiple Answers Question
- Prizes/Vouchers setup and creation
- AR TH publishing - Private and Public

AR Treasure Hunt Creator User Manual can be found in Entropy project repository on the following link:

3.3 **AR Treasure Hunt Creator Demonstrator**

The following figures give some examples of AR Treasure Hunt creation process, while more details can be found in Treasure Hunt Creator User Manual.

*Figure 5: Import of image marker for AR Treasure Hunt game*

*Figure 6: Import of content that will appear upon scanning of AR marker in AR Treasure Hunt*
Creation of Questions with multiple or single answers:

Figure 7: Question and answer(s) creation process for AR Treasure Hunt game

Creation of Vouchers with QR codes for validation process:

Figure 8: Creation of Vouchers with QR code for validation purposes in AR Treasure Hunt game
4. KPIs for Entropy Serious Games

4.1 Behavioral Indications Calculations

This data mining and analysis process regards the calculation of a set of indicators related to the profile of end users with regards to energy efficiency. Such indicators include Engagement, Knowledge and Effectiveness. These KPIs were analyzed and produced in W2 Deliverable 2.4. Calculation of indicators is realized at periodical points in time, taking into account the interaction of end users with the mobile app and the serious game accordingly. Through calculation of “Engagement” (KPI), “Knowledge” (KPI), “Effectiveness” (KPI) with the mobile apps, important conclusions can be drawn that will drive recommender decision making. These digital interactions will be stored in the main database and calculate/re-evaluate engagement metrics and some aggregated KPIs will be computed every day or every week respectively (see D4.1 report).

4.2 Overview of KPIs for Entropy’s Serious Games

The following tables give overview of Quantitative, Qualitative and Game specific performance evaluation criteria, and associated KPIs that will be used for Pilot run stage of the project (to be reported as part of WP5).

Table 2: Quantitative Characteristics (see D1.5 for more details)

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>KPIs</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interoperability</td>
<td>Input/Output; Ability to expose and receive services to APIs</td>
<td></td>
</tr>
<tr>
<td>Technical Learnability</td>
<td>% coverage of features with learning documents/ online documents</td>
<td></td>
</tr>
<tr>
<td>Availability [%]</td>
<td>Software downtime over total running time</td>
<td></td>
</tr>
<tr>
<td>Error Rate</td>
<td>No of problematic request over total number of requests</td>
<td></td>
</tr>
<tr>
<td>Fault Tolerance</td>
<td>Number of software problem identified</td>
<td></td>
</tr>
<tr>
<td>Modularity [%]</td>
<td>Number of components that can operate individually</td>
<td></td>
</tr>
<tr>
<td>Reusability [%]</td>
<td>Number of reusable assets</td>
<td></td>
</tr>
<tr>
<td>Instability [%]</td>
<td>Number of minutes required per installation over total number of minutes for all installation</td>
<td></td>
</tr>
</tbody>
</table>

Table 3: Qualitative Characteristics (see D1.5 for more details)

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>KPIs</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functional Completeness</td>
<td>Level of completeness in terms of Entropy project requirements</td>
<td></td>
</tr>
<tr>
<td>Functional Correctness</td>
<td>Does software produce accurate results</td>
<td></td>
</tr>
<tr>
<td>Ease of Use</td>
<td>Level of ease of use (UX) (1 to 5)</td>
<td></td>
</tr>
<tr>
<td>User Interface Aesthetics</td>
<td>Does the aesthetics of UI appeals to the users</td>
<td></td>
</tr>
<tr>
<td>Usefulness</td>
<td>Do user find serious game to be useful</td>
<td></td>
</tr>
<tr>
<td>Privacy</td>
<td>Privacy Index – does software works according to EU privacy regulations</td>
<td></td>
</tr>
</tbody>
</table>
### Table 4: AR Treasure Hunt game specific metrics

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>KPIs</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unique users</td>
<td>How many unique users have used the app</td>
<td></td>
</tr>
<tr>
<td>Sessions</td>
<td>A session is one use of the application by an end user</td>
<td></td>
</tr>
<tr>
<td>Session Length</td>
<td>The session length is the length of time between the start application event and the end application event.</td>
<td></td>
</tr>
<tr>
<td>Active Users</td>
<td>An active user is a user that has had at least one session with your application during a given time period (days, weeks, months)</td>
<td></td>
</tr>
<tr>
<td>New Users</td>
<td>A user who has just started using your application. Users are identified by their unique IDs</td>
<td></td>
</tr>
<tr>
<td>Frequency of Use</td>
<td>Frequency of use is a measure of how many sessions unique users had over a given period of time</td>
<td></td>
</tr>
<tr>
<td>Page views</td>
<td>How often pages (every page or number of specific pages) in your app have been viewed</td>
<td></td>
</tr>
<tr>
<td>Clicks Through</td>
<td>How many times have your viewers clicked through from your app to a specific (predefined) button</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>KPIs</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vouchers won</td>
<td>Number of vouchers won per user and overall</td>
<td></td>
</tr>
<tr>
<td>Vouchers validated</td>
<td>Number of vouchers validated per user and overall</td>
<td></td>
</tr>
<tr>
<td>Total score per user</td>
<td>Total score per user per game</td>
<td></td>
</tr>
<tr>
<td>Max score per game</td>
<td>Maximum score per game</td>
<td></td>
</tr>
<tr>
<td>Number of actions done per action type</td>
<td>Number of actions done per user</td>
<td></td>
</tr>
<tr>
<td>Number of actions done per action type</td>
<td>Number of actions done per user per action type</td>
<td></td>
</tr>
<tr>
<td>Estimated saving per action done</td>
<td>Estimated energy saving per action done per user</td>
<td></td>
</tr>
<tr>
<td>Total energy saving per user per game</td>
<td>Total energy saving per user per game / energy efficiency behavior</td>
<td></td>
</tr>
<tr>
<td>Award mechanism</td>
<td>Awards mechanism selected by the user/ user profiling</td>
<td>......</td>
</tr>
</tbody>
</table>
5. CONCLUSIONS

This document delivers the required applications, documents and testing procedures in order to deliver series of Treasure Hunt games based on Augmented Reality, Recommendations and Real time Data visualization, together with different gamification elements that will be used to motivate users towards adopting energy efficient behavior in public buildings. KPIs are presented which will be supported by ENTROPY platform which will help evaluation of AR Treasure Hunts serious games.