WaterSocial.org as the social platform aimed to promote an efficient water use

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Abstract—ISS-EWATUS is a EU founded project which aims to increase the effectiveness of water saving awareness. One of its key components is the social media platform, along with connectors and information exchanging throughout whole system. In this paper, the brief description of this platform is stated, as well as the dissemination results of a whole ISS-EWATUS project.

I. Introduction

WATERSOCIAL.ORG is an online social media platform (SMP) that was specially designed for promoting an efficient water use. This platform was designed and developed as a part of the project named Integrated Support System for Efficient Water Usage and Resources Management (ISS-EWATUS) [1], [2]. By using this website, ISS-EWATUS has established a supportive community of users who are willing to take on the role of a "local leader" in changing the water behaviour of a local community[3]. This includes its impact on local, national and international levels across Europe and its target audiences of water stakeholders at different levels of individuals, households, green NPOs, water managers, researchers and policy makers. The SMP aims to ease the communication and creation of relationships between stakeholders and to produce a sustainable impact for the communities involved. Apart from supporting mainstream social networking activities such as sharing, communications, being friends, asking and answering, discussion, the SMP allows users to share water tips and photos under different environmental scenes, and the shared content can be pinned on a global map. Gamification enables the entire SMP to be used as a platform with gaming elements, which involve game tasks, competitions and rewards. The game tasks can be any user tasks on the social networks or any water use related offline activities such as recording water use activities. Each of these user tasks can be rewarded upon accomplishment. The rewards system has paid off in terms of acquiring users and convincing them to change their behaviour. Watersocial.org is unique in its vision to harness gamification and social media to reinforce water saving behaviours. It incorporates a set of gamification designs into the online social networking activities in which the users are able to get rewarded upon each accomplishment of a task or even are able to compete with each other through the WaterSocial.org leaderboards.

II. Gamification in WaterSocial.org

Gamification refers to the use of game design elements in non-game contexts such as gaining rewards from competition or participation. It can be used to engage communities of interest in changing behaviours. In the WaterSocial.org platform, the gamification mechanism is driven by three motivational affordances including Aqoins, Titles and Leaderboards. *Aqoins and* Titles can be won by participating to a variety of social networking activities; while the leaderboards allow users to compete with each other.

A. Aqoins and titles

Aqoins are points that used to reward user activities on the platform. In order to encourage more user activities, most of the activities can be used to earn Aqoins. Table 1 shows the tariffs of each activity: after completing any of the activities illustrated, users will be rewarded with the corresponding aqoins.

When a user earns certain amount of Aqoins, they can obtain titles (see Figure 1).

B. Leaderboard

The leaderboard aims to trigger more "social comparison" so that more user engagement can be achieved. There have been implemented three types of leaderboards, namely the weekly leaderboard within friend circle, monthly leaderboard within the whole community and the all-time leaderboard which includes all users throughout all time.

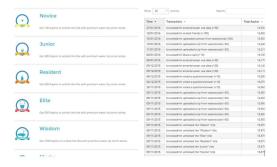| User Activities	Aqoins
submit data to water diary	30
ask a new question	30
answer a question	10
reply an item from social stream	10
like a topic	10
vote a question/answer	10
upload a photo from mobile app	80
upload a photo on map	60
post texts including tips on map	30
reply a topic discussion	20

Fig. 1. My aqoins page

Fig. 2. Leader board page

III. SOCIAL-MEDIA PLATFORMS ENGENDERING SOCIAL ENGAGEMENT AND BEHAVIOUR CHANGE

According to a report from Pew Internet Project3, as of early 2014 74% of the online adults use social networking sites. A qualitative study conducted in the UK by Binsted & Hutchins [5] mapped individuals' usage patterns of social networks, namely: keeping in touch with contacts, sharing photos, playing games, following celebrities, organising social events, getting recommendations, as well as gaining and sharing information.

In addition to the general social network sites (e.g. Facebook, Twitter, and Google+), there are many other ones focused on specific topics. Some of them are linked to sports and life-style apps, such as Endomondo, RunKeeper, and WeightWatchers. These applications provide users with communities to exchange information about performances, to keep each other up-to-date, and to link their account with other

networks. In the water conservation field the use of social networks are also emerging. For instance, Twitter has often been used as a media to share news and tips about water uses (Water-Use It Wisely).

Additionally, Facebook has been used to post water use related news to rise people's awareness of water conservation such as Water - Use It Wisely4. Since social networks are an emerging trend and their applications are growing very rapidly, it has a high potential to persuade people to practice water conservation.

A. Social Engagement

Self-gratification plays an important role in explaining why people tend to voluntarily take part in the social networks. It includes the gratification received from entertainment, information seeking, and social interaction [6], [7], [8]. Getting to know new people with common interest in order to share ideas seems to be one of the main reasons for people to use a social-media platform [9]. Furthermore according to the same research, people are interested in getting updates from their social network connections as this makes them better informed about other people's activities and opinions. In [10], self-gratification is further defined as one's attachment, sense of duty and good way to meet people, in the political context, which in turn are argued to play a major role towards influencing citizens to help curb social problems.

In addition to psychological factors, there are also other objective factors or incentives to cause people to join social networks. For example point systems (such as scores, stars, reputations and badges) are a common practice in many game applications. In some social forums, question and answer Websites, there is also an increasing number of computer and smartphone games that use point system to motivate players to keep playing the games. Reasons of why such a reward system is successful can perhaps be explained by using behavioural model of [11]. He argues that an activity that is easy to do (such as playing games) will require only low motivation for a person to finally do it. Thus, triggers, such as points, may be enough for making him/her play a game. However, when an activity is hard to do, it will require much higher motivation. Therefore, different kind of triggers may be needed to boost motivation.

B. Social Behaviour Change

Behaviour can be influenced through social norms. People are more likely to participate in an activity if those around are participating in the activity. Previous studies including [12] have also indicated that social media/networks can be used to motivate or to give certain pressure to people to behave in certain ways. One study performed in [13] showed that water conservation could be influenced by the presence of people modelling the promoted water saving action of turning off the shower while soaping. It was found that before the study 6% of shower users carried out the action while 93% were aware of the sign suggesting the action. Following the presence of

one role model, 49% carried out the action. The presence of two role models resulted in 67% participation.

Behaviours can also be influenced via designed intervention. [14] defines a concept called CBSM (Community Based Social Marketing) referring to intervention programs that attempt to apply a structured approach and the insights of social psychology when influencing community behaviour. CBSM approach has been found to be effective in changing routine behaviour and the design of CBSM has been further developed in [15]. There four steps to design a CBSM, the first step involves recognising the behaviours relevant to a particular environmental goal, for example, installing a low-flow showerhead. CBSM starts with identifying the barriers which prevent the action from being taken, and then selecting a specific barrier to promote based on its potential impact on the behaviour campaign, the relevance to the behavioural change and the resources available to overcome the barrier. The chosen barrier varies depending on whether the desired behaviour change is a one off action, or involves changing a particular habit or routine. The study in [15] cognises that habitual or routine change is much more difficult to influence compared to changing a one-off behaviour. The second step is to design a programme to overcome the selected barrier to achieve the behavioural change. The important aspect of the design stage is to target interventions very specifically towards the identified barriers, drawing on social-psychological devices such as commitments, prompts, or signals, to promote the desired behaviours. The third and final steps in the CBSM approach are piloting and testing the programme and evaluating its effectiveness before it is applied on a wider scale.

IV. Design and Implementation of WaterSocial.org

This chapter details the development aspects of WaterSocial.org. The system architecture, the components and their connectors are described, together with the process model and the data model of each component. The process model is needed to show the degree of interactions of the component with other components; the data model is needed to show the data structures and information flowing from one component to the other, as part of their interaction.

In the next few sections, each of the modules is presented in terms of process model, data model and their current deployment status in the system.

A. Software components

The software components are shown in Figure 3 (with the indication of which of the project tasks are implemented in). These components seek to fulfil the scenarios and the associated use cases defined in the gathered requirements via the following modules:

1) ISS-EWATUS Web Portal (ISNP): This is the landing Web page for the whole system.
2) ISNP Data Sensing (IDS): It detects social networking activities including sharing and inter-user communication and individual user water use input to the system.

IDS is cross-platform which means it also can receive data from multiple devices such as mobile phones and laptops. In addition, it also stores and dispenses the pre-processed data flows to other expected SMP components.

3) Water Use Visualizer (WUV): It performs the visualisation features which enable the system to present the water use patterns in different media forms such as charts, histograms from different dimensions such as temporal and activity.
4) Water Use Pattern Visualization (WUPV): This is the front end component that handles the user input from WUV.

V. Inter-component interactions

Interactions connect modules within components. Below we report, for each interaction, their process and data models, and the API specifications to implement these interactions. Also, the modules that are connected by each interaction are described. The modules are associated to three types of inter-component interactions, as defined below:

1) Social Network Activity and Water Use Visualization
2) Gamification
3) Evaluation

Interactions connect modules within components. Below we report, for each interaction, their process and data models, and the API specifications to implement these interactions. Also, the modules that are connected by each interaction are described.
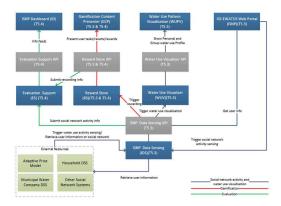

Fig. 3. ISS-EWATUS SMP Components

A. Inter-component Interactions: Social Network Activity and Water Use Visualization

This inter-component interaction has the purpose of handling, for each user account, the user account management; the social network activity management; and the water use visualization. The interactions that are allowed are two-fold:

1) internally to the SMP, its components interact through this layer at the user-level,

2) externally, the interactions also extend to components outside the SMP, such as the household DSS (within the ISS-EWATUS scope) and the other social network systems (outside the ISS-EWATUS scope) to allow them to retrieve information provided by the platform.

1) Process model: Below we display the process model of the cluster of interactions named "Social Network Activity and Water Use Visualization". It is presented in a UML Sequence Diagram, where the main components are shown in their box, and the interactions are the arrows that travel between them.

At current implementation, we have enable the new user registration, post/reply and water use diagram request processes.
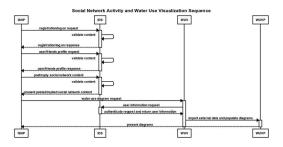

Fig. 4. Process model for social network activity and water use visualisation

2) Data Model: The data model used in the platform customises and extends the data structure supplied in the WordPress database framework. There are mainly three types of data types used in this module.

1) user: contains user information that comprises the use profile,
2) posts: defined as a base data structure used to be extended and implemented to define user input and other component data input to SMP,
3) postmeta: used to define the additional data fields in forms of key-value pairs of an extended posts type.

Figure 5 shows the user data structure, the full details of data field definition can be viewed on http://watersocial.org/extensions-json/rest/api/users/schema.

Figures 6 and 7 show the base posts type and post meta data type data structures. In the platform we particularly extended the base posts type in terms of the post_type data field which allow the platform to handle different social networking activities input (see Table II). We also implemented three platform original data types used to handle user input of water use, water use tips and water use images, namely the tips object (see Figure 8), media object (see Figure 9). The descriptions of data fields of these two objects can also be found at http://watersocial.org/extensions-json/rest/api/tips/schema and http://watersocial.org/extensions-json/rest/api/media/schema.

As the platform is a Web-based application system, we developed a set of Web APIs (application programming interface) which allow the platform data can be accessed and managed within and outside the platform. The Web API here is defined as an API for either a Web server or a Web browser.

Fig. 5. User type data structure

TABLE II
CUSTOMIZED POST TYPE USED THE PLATFORM

Post Type Used in the Platform	Use
achievement-type	To store different types of the gamification tasks
answer	To store users answers in the Questions and Answers activities
attachment	To store user uploaded content such as images
badge-log-entry	To log users' rewarding transactions
bgmp	To store geo-related content such as tips and photos
faq	To store FAQs of website
forum	To store different types of forums
mobilechallenge	One of the achievement-type defined for mobile users
question	To store users' questions in the Questions and Answers activities
reply	To store users' replies for a forum topic
title	One of the achievement-type defined for all users
topic	To store users' topics in a forum
watersocial_survey	To store survey answers
wateruse	To store water use diary input from individual users
contact_form	To log messages sent to users from manager

The INSP and IDS components expose a set of Web APIs by using Restful Web services. This allows the SMP to be flexibly integrated with heterogeneous systems including Android and/or iOS apps. The APIs are well documented

Fig. 6. Posts type data structure

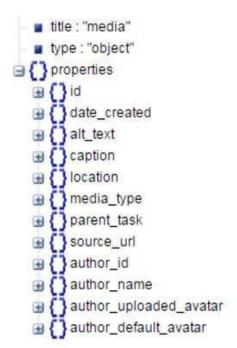Fig. 8. Tips object, the full schema definition can be found at http://watersocial.org/extensions-json/rest/api/tips/schema

Fig. 9. Media object, the full schema definition can found at http://watersocial.org/extensions-json/rest/api/media/schema

Fig. 7. Post meta data structure

in thehttp://watersocial.org/extensions-json/rest/api where IDS and WUV APIs are included and general descriptions of these APIs are given below (see Table III and Table IV).

B. Inter-component Interactions: Gamification

The gamification enables the whole SMP to be used as a platform with gaming elements, which involve game task, competition and rewarding. The game tasks can be any user tasks on the social networks or any water use related offline activities such as recording down water use activities. Each of these user tasks can be rewarded upon its accomplishment. The gamification mechanism provided here allows managers to design user tasks and to reward points/badges as the user task progresses. The components involved include:

- **Reward Store (RS)** plays a pivotal role in incentivising users participating in the whole system. The features of RS include calculation of rewards such as points, experience level, ranking etc. for each gamified social network activity. RS outputs the rewarding results in the forms of leaderboard of users and notification of rewards on an individual basis.
- **Gamification Content Presenter (GCP)** is a front end component which handles information from RS.

1) Process Model: The gamification process involves user task design, task status check and rewarding procedures (see Figure 10).

TABLE III
IDS APIs

URL	Method	Description
/rest/api/ users	GET	Get all users and users can be sorted by id, total earned points, registered date and user name.
/rest/api/ users	POST	Create a user object.
/rest/api/tips	GET	Get a collection of tips objects
/rest/api/tips/ \{taskid\}/ \{longitude\ })/\{latitude\ }	POST	Upload a tip under a particular gaming task at current geographical location. The tip can also be automatically published to forum topic and twitter once approved by the platform via this API.
/rest/api/ users/\{id\}/ friends	GET	Get a user's friends of WaterSocial.org by user id, the retrieved friends can be further sorted by id, total earned points, registered date and user name.
/rest/api/ users/\{id\}	POST	Update a user's profile by user id.
/rest/api/ users/\{id\}	GET	Get a user's profile
/rest/api/ media	GET	Get all media files uploaded by users
/rest/api/ media/ \{taskid\}/ \{longitude\ })/\{latitude\ }	POST	Upload a media file under a particular gaming task at current geographical location. The tip can also be automatically published to forum topic and twitter once approved by the platform via this API.
/rest/api/ media/tasks/ \{taskid\}/	GET	Get all media files under one task
/rest/api/ media/\{id\}	GET	Get all a particular media file by media id

TABLE IV
WUV APIs

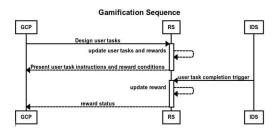| URL	Method	Description
/rest/api/ diary/ {taskid}/ {longitude}) /{latitude}	POST	Record a water use under a particular gaming task at current geographical location. The tip can also be automatically published to forum topic and twitter once approved by the platform via this API.
/rest/api/ diary/tasks/ {taskid}/	GET	Get all diary records of a user from that requesting user.

Fig. 10. Process model for gamification

2) Data Model: There are two data objects defined in this module namely the task object and reward object. The specifications of two objects are defined online. The tasks object is defined in http://watersocial.org/extensions-json/rest/api/tasks/ schema (see Figure 11) and the reward object is defined in http: //watersocial.org/extensions-json/rest/api/rewards/schema (see Figure 12).

Fig. 11. Task object, the full schema definition can be found at http: //watersocial.org/extensions-json/rest/api/tasks/schema

The Web APIs for RS include those used to retrieve the points from the platform and those from the external game service providers (see Table V).

TABLE V
RS APIs

URL	Method	Description
/rest/api/ rewards/ {userid}	GET	Get a rewards of a user.
/rest/api/ rewards/ game	GET	Get point redemption code from watersocial, this API is used to integrate the games from outside the platform.
/rest/api/ rewards/ game/ decrypt/ {code}	GET	Get points value from a rewarding code. This code is generated from WaterSocial.org for external game service provider.

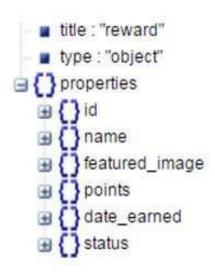In addition to the Web APIs, there are also APIs that used

Fig. 12. Reward object, the full schema definition can be found at http://watersocial.org/extensions-json/rest/api/rewards/schema

to specifically target the game tasks. In the platform, the following task actions APIs are developed to support gamified social networking tasks and water use tasks. The use of these APIs can follow the pattern *add_action(ACTION_NAME, CUSTOMISED_FUNCTION)* in a WordPress plugin.

TABLE VI
GAME TASK ACTIONS APIS

Action Name	Description
publish_wateruse	It can be used if a user uploads a water use diary.
publish_question	It can be used if a user posts a new question in Q&A feature.
publish_answer	It can be used if a user posts an answer in Q&A feature.
bp_activity_comment_posted	It can be used if a user commented in social activity stream.
wp_ulike_mycred_like	It can be used if a user unlike or like a topic.
ap_vote_casted	It can be used if a user vote for an answer/question in Q&A feature.
publish_bgmp	It can be used if a user posts some information on the map, e.g. a photo or a tip.
publish_reply	It can be used if a user replies a topic.
send_friend_invitation	It can be used if a user sends invitation of join water social on other social networks.

C. Inter-component Interactions: Evaluation

Evaluation allows managers and researchers to continuously monitor and get the statistics of users, social network activities and rewards information. There are two components designed to handle these tasks, namely:

- **Evaluation support (ES)** is the component serves dashboard, it collects data from RS and IDS so that it can produces summative results of rewarding and all other social network activities occurred. ES performs different statistical features to produce the meaningful results.
- **ISNP Dashboard (ID)** This is a Web based application that presents the results generated from ES based upon a user's privilege.

The detailed description of the evaluation is beyond of this paper.

VI. DISSEMINATION OF WATERSOCIAL.ORG

A number of dissemination activities were carried out between 1st January 2016 and 30th December 2016. To disseminate the WaterSocial.org the following types of activities were undertaken: 1. Online activities: a) Social media: the use of social media platforms to share water saving messages. b) Publications: newsletters and blogs that detailed the WaterSocial platform. 2. Offline activities: a) Competitions: to enhance the gamification layer. b) School visits: pupil engagement that showcased the WaterSocial platform. These activities are related as they all publicised the WaterSocial platform by promoting water saving messages [4]. Their monitoring and analysis help in evaluating whether a measurable user uptake has been observed and the types of messages used and the degree of relevance to users. The results of the portal dissemination have been very satisfying, for example 102 new users were registered to WaterSocial.org, 127 friendships and 145 topics were created.

ACKNOWLEDGMENT

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