

# Gamification of Tour Experiences with Motivational Intelligent Technologies

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**Abstract**— SUMMIT is a mobile app that aims to gamify the experience of walkers and hikers and benefit the local communities through which they perambulate. It encourages physical activity through gamification of the user experience by adding additional elements of social fun and motivation to walking and hiking activities. It rewards users for their physical effort by offering access to local resources, hence increasing awareness and appreciation of the local assets and heritage and contributing to the local economy. The evaluation results show that both businesses and walkers were very receptive to the idea. A modified version of SUMMIT, the Science Safari App was implemented in a zoo setting and its potential implications are discussed.

**Keywords**—Location based; gamification; personalisation; rewards; tourism; mobile application.

## I. INTRODUCTION

SUMMIT [1] is a location-based mobile app that encourages the walking and hiking community to avail themselves of local resources including hospitality businesses, product vendors, tourist attractions and local information.

Romanticism era in the 18<sup>th</sup> century brought forth a shift in attitudes to the landscape and nature leading to the manifestation of the idea of walking through the countryside for pleasure [2]. An explosion of long distance walking routes occurred in the late 20<sup>th</sup> century with the Appalachian Trail in the USA [3] and the Pennine Way in Britain [4] as early examples. In Scotland, tourism figures from 2012 show that walking and hiking was the second most popular tourist activity among domestic visitors [5]. However, for many of these visitors, the walk can be the sole purpose of their trip and they may not access any other local attractions or local businesses.

The key goal of SUMMIT is to “gamify” the user experience by adding additional elements of social fun, motivation and rewards to walking activities whilst increasing cultural appreciation through promotion of the local amenities and services to the benefit of the local economy.

The idea behind it is to challenge walkers and hikers to reach checkpoints (geo-fenced areas) that are located along popular walking and hiking routes. When walkers reach a checkpoint they are presented with a list of rewards on their mobile app from which they can choose their favourite as illustrated in Fig. 1. The rewards are provided by local

businesses in the area and may include things like a free muffin or a 20% discount on a product. For example, if the walker decides to choose a free muffin as his reward at some checkpoint, he selects this in his app and a virtual muffin is added to his “reward knapsack”. He then takes this virtual muffin to the local shop that offered this reward to exchange his virtual muffin for a real one. While he is there he may also buy a coffee or take friends with him who may also make some purchases.

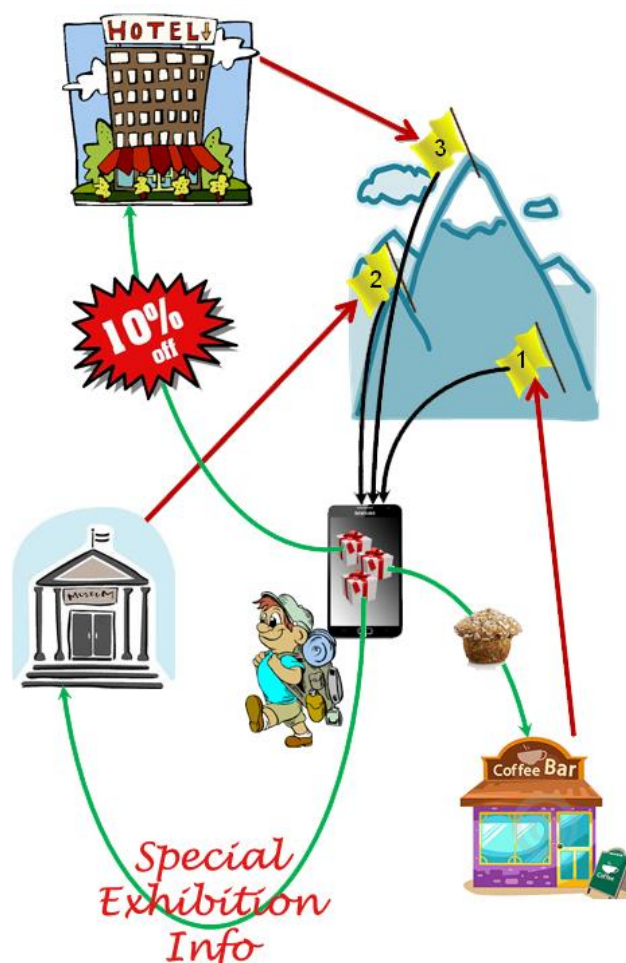


Figure 1. SUMMIT reward scheme.

In this way, SUMMIT benefits both walkers and local businesses. It encourages physical activity by making such activities more fun and rewarding but also introduces walkers and hikers to new local resources in the area that they might not have visited otherwise.

Additionally, a great advantage of SUMMIT is its flexibility and extensibility. With some adaptations SUMMIT is deployable at different tourist sites with many points of interests where a stimulating route can be generated to improve visitors' tour experiences. One such place is the zoo. During Explorathon'15 [6] at RZSS Edinburgh Zoo [7], the Science Safari App, a modified version of SUMMIT was released to visitors. The Explorathon'15 at RZSS Edinburgh Zoo held on the European Researcher's Night, which takes place simultaneously every year in hundreds of cities across Europe and beyond is a mini science festival where scientists from Edinburgh's universities showcased their ground breaking research to the public. The Science Safari App was used to guide visitors around the different science exhibits on display.

The rest of this paper is organised as follows. Section II presents the related work. Section III presents the findings from a focus workshop carried out prior to development while Section IV presents the design of SUMMIT, both the mobile and web apps. An evaluation of the first prototype that was carried out in the wild on Arthur's Seat in Edinburgh, Scotland is detailed in Section V along with the results and discussions. Section VI presents the Science Safari App and some potential implication of its application in the zoo setting. Section VII concludes the paper.

## II. RELATED WORK

Pervasive gaming takes the gaming experience into the real world, focusing on introducing game elements into the everyday life of players. It exploits interaction devices such as handhelds to display virtual elements [8], generates location-sensitive responses to interaction [9], employs technology through which human game-masters can exercise control of the game experience [10] and involves interactive actors to perform non-player characters [11].

Pirates! [12] was one of the first successful attempts to port the computer game into the real world and the IPerG project [13] has successfully executed a number of pervasive games in real spaces such as Epidemic Menace [14] and Day of the Figurines [15]. Other groups have produced educational pervasive games such as Virus [16] and Paranoia Syndrome [17]. Artistically oriented pervasive games such as Can You See Me Now? [8] used whole cities as the game environment. Ludocity [18], a collection of pervasive games inspired by theatre, painting, dance and other art forms also exploits public places such as city streets and parks for social play. All Ludocity games are released under creative commons licences, which allow everyone to run the games for free. Ingress by Google [19] is a near real-time augmented reality massively multiplayer online pervasive game with a complex science fiction back story and continuous open narrative.

On the other hand, SUMMIT is a real-world outdoor treasure hunt game using Global Positioning System (GPS)-

enabled devices inspired by geocaching [20]. Analogous to geocaching, SUMMIT "hides" rewards of different categories at different places along a popular route for users to find and collect. These rewards reflect the distinctive resources offered by the local area and community encouraging users to appreciate and take advantage of the local amenities on offer. SUMMIT also logs users' achievements and allows them to perform social comparison of their performance against others, thus introducing a competitive element to the overall walking/hiking experience.

To date, quite a few treasure hunt based pervasive applications aiming at increasing cultural heritage appreciation have emerged including the Stealit App [21], Regensburg REXplorer game [22], the Global Treasure Apps [23], the Museum Explorer [24] and Huntzz [25].

The Stealit App was developed for the National Museum of Scotland in Culture Hack Scotland 2011 by Alex Waterson and Jen Davies. It maps over 1000 items from the museum collections onto Festival venues throughout Edinburgh and encourages players to "steal" them. The Global Treasure App entice users to follow clues at different tourist attractions to collect gold, silver or bronze treasure tokens and real-world rewards such as a badge or money off in gift-shops and cafes. In the Museum Explorer App, users have a mission to track down nine mystery objects within the museum to unlock special explorer badge. The Huntzz App allows anyone to create and share treasure hunts.

The main difference between these applications and SUMMIT is that these applications do not reward users based on physical achievements but on solving puzzles and clues. Only the Global Treasure Apps include real-world rewards but the focus is on promoting artifacts and attractions rather than local businesses and communities.

Although other stamping schemes for tourist checkpoints exist [26], these schemes usually require all checkpoints to be reached to validate the completion of a tour with the aim of collecting badges or similar rewards. On the other hand, SUMMIT users do not need to reach all checkpoints to collect rewards and have the flexibility of choosing their desired rewards. Instead of automated checkpoint verification, the stamping schemes involve manually dating and stamping of a personal completion brochure or manually entering codes collected from checkpoints on the respective websites for electronic validation.

Many zoos have created their own mobile apps such as the ZSL London Zoo App [27], Chester Zoo App [28], the Smithsonian National Zoo App [29] and the Dinosaurs Return App [30]. Most of these applications focus on helping visitors find their way around and discover the different animals and attractions available.

The ZSL London Zoo App, the Chester Zoo App and the Smithsonian National Zoo App all present animal facts, photos and videos, incorporate a GPS-enabled interactive zoo map and a planner showing all daily events around the zoo. Additionally, the ZSL London Zoo App features a Walkabout Game where visitors have to find and photograph animals to win prizes. Users of the Chester Zoo App can

collect special animal badges as they walk around the zoo. The Smithsonian National Zoo App on the other hand lets anyone with Android or iOS mobile devices enjoy the zoo wherever they are with its virtual component.

The Dinosaurs Return App was developed in conjunction to the Dinosaurs exhibition [31] at RZSS Edinburgh Zoo. The exhibition took place from April to November 2015 aiming to raise awareness about the real threat of extinction faced by many endangered species today. Visitors can watch dinosaurs come alive in the palm of their hand by scanning augmented reality tags scattered around the site. There is also a dinosaur quiz and an exhibition map to aid visitors.

The Science Safari App was developed from the SUMMIT project and targeted a range of scientific research exhibits at RZSS Edinburgh Zoo as part of the Explorathon'15 event [10]. SUMMIT is easily extensible to any locations in the world by adding new routes information and checkpoint coordinates, hence providing a quick way to generate interesting routes and create awareness in visitors about what is on offer at one-off events such as Explorathon'15 as well as longer term local resources.

### III. DESIGN WORKSHOP

SUMMIT was proposed for the Fort William area [32]. To inform the design of SUMMIT, we met with our contact from Visit Fort William [33] to discuss requirements both from hikers and businesses point of view. Through this collaboration, we identified three interesting routes around the area including Ben Nevis, Glen Nevis and Kinlochleven.

A site analysis of the Ben Nevis area confirmed our expectations that the 3G signal is intermittent and cannot be relied upon. GPS and mobile network connectivity loss can have a negative impact on the user experience if not handled appropriately. Hence, a mechanism that allows users to have an uninterrupted interaction is vital to the system.

Additionally, we ran a focus workshop with hikers and walkers to understand more about their use of technology when out in the wild. The group provided some interesting suggestions for before, during and after the hike.

Before the hike, it was proposed that weather forecast, route information on a map, predicted completion time and a checking in feature to say that they are going for a hike would be useful. During the hike, the ability to connect to social network for sharing, performance measure, alert to possible interesting diversion and emergency button to call for help are desirable. After the hike, there need to be a feature for checking out to say that they have completed the journey as well as the ability to view collected rewards.

Some interesting issues were also raised such as concerns about draining battery power, suggestion for group specific rewards and some views that information about the local town might be more important than real-world rewards. They also mentioned that during a walk/hike, they usually keep their phones in the pocket.

Moreover, there seemed to be a consensus that the target group for the app is the younger generation. Personalisation of rewards to age groups or user types can be beneficial.

These feedbacks informed the design of the SUMMIT service including seamless connectivity, availability of a route map, information about estimated distance and completion time, a check-in check-out feature, ability to share on social network sites such as Facebook, ability to view an assortment of rewards and select them as well as the need for minimum interaction with the service while en route.

Unfortunately, due to limited time and resources, we were not able to implement suggestions such as weather forecast, real-time performance measure, interesting diversion alert, emergency help button or personalisation of rewards but focused on those deemed important for the purpose of the SUMMIT service.

### IV. THE SUMMIT SYSTEM

The SUMMIT system consists of two main components: a web app, which allows business users to manage the rewards that they provide, and a mobile app, which is used by the walkers and hikers. Fig. 2 illustrates the SUMMIT system deployment including the server where information about business users and app users are stored.

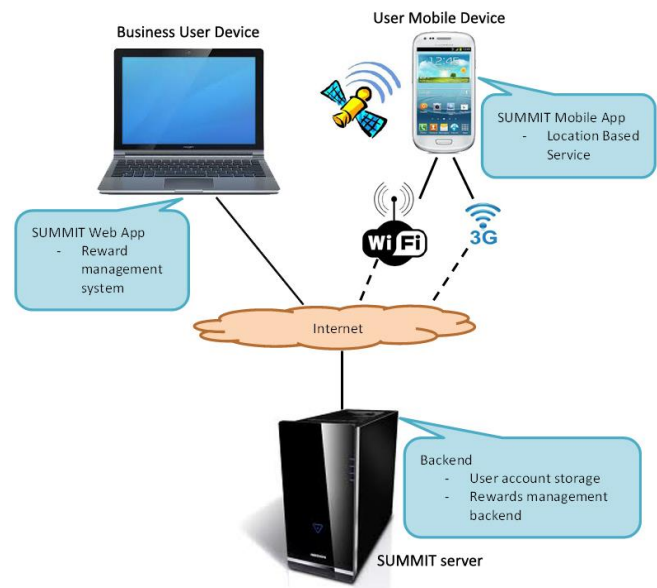


Figure 2. SUMMIT system deployment.

#### A. SUMMIT Mobile Application

The mobile app was developed for the Android platform. It aims to enhance the walking activities by supporting the users' personal achievement element through a reward scheme and the social competition element through comparisons of their progress against others via the social network site, Facebook.

The mobile app monitors the users' outdoor locations while they are en route using GPS. Each route has several pre-defined checkpoints, usually selected based on their touristic values to the respective region that are geo-fenced

areas. The app does not provide real-time navigation but as users reach checkpoints, the phone will start vibrating and notifications will appear on the system bar. When this happens, users will unlock new virtual reward items provided by local businesses, which they can exchange into real rewards.

Prior to the hike, users can check out different routes and rewards associated with each of the routes. They can then select a route that provides the rewards they desire and suits their constraints in terms of time and distance. This flexibility enables users to personalise their tour experience based on their needs at any particular time.

Fig. 3 shows the workflow of the mobile app. Before users can use the mobile app, they have to register. After they have registered and logged in, they will see 5 tabs including ‘Route’, ‘K-sack’, ‘Reward’, ‘Claim’ and ‘Facebook’. Fig. 4 shows the Login Screen of the app while Fig. 5 shows the ‘Route’ tab, which lists the available routes, estimated distance and time as well as the checkpoints and rewards associated with each route.

When users select a route, the route information will be downloaded onto their phone assuming Internet connection is available. By pre-loading the routes, the issue of unreliable 3G signal is avoided as the route information is now locally stored, hence will always be available to users when en route.

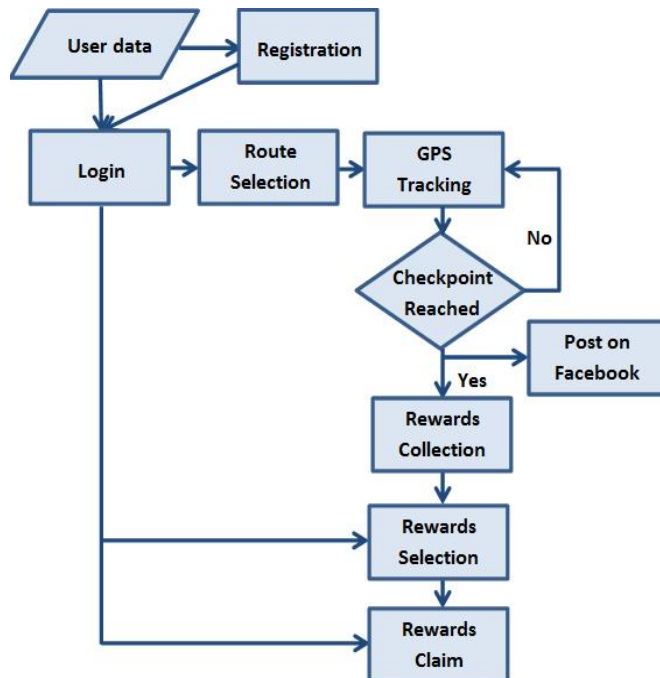


Figure 3. SUMMIT mobile app workflow.

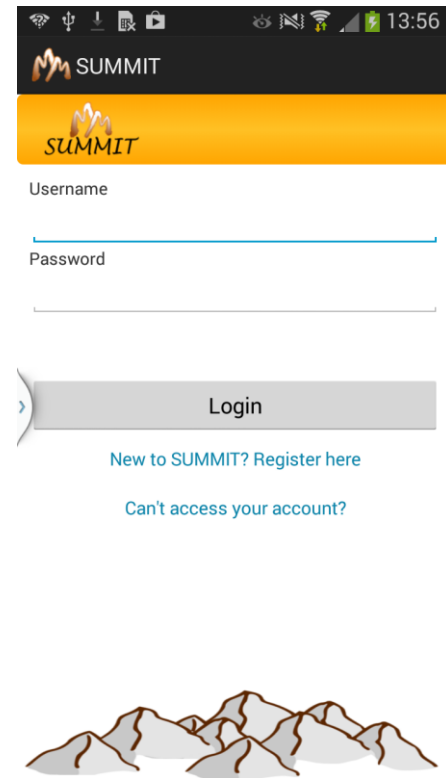


Figure 4. ‘Login’ screen.

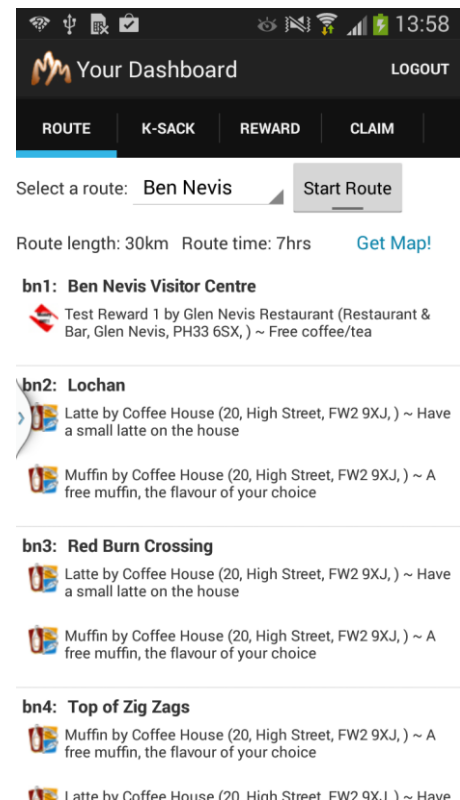


Figure 5. ‘Route’ tab.



When the user is ready for the hike, they check-in by pressing the “Start Route” button, which activates checkpoints tracking. During the hike, only GPS signal is required to track users’ position. Since each checkpoint covers an area of 50 metre radius, a short loss of GPS signal does not affect the performance of the app. These approaches give users a virtual “Always-On” connectivity impression allowing them to have an uninterrupted interaction experience. The problem of draining the battery power is also minimised as the phone is not constantly connected to the network. Synchronisation with the server occurs the next time network connectivity is available and activated by the user when all logged data on the mobile device is uploaded.

To help users locate the rewards, a map that shows the locations of the different checkpoints is provided as illustrated in Fig. 6. The associated rewards will automatically be added to the user’s knapsack (“K-sack” tab) at each checkpoint. When network connection is available, users can select one reward for each checkpoint through a selection dialog as shown in Fig. 7.

After they have made their selection, the rewards will appear under the “Reward” tab. To claim a particular reward on this list, the user needs to tap on the reward and a claim dialog as shown in Fig. 8 will appear. By clicking claim, the reward will appear under the “Claim” tab and on the supplier system (for the web app description, please refer to Section B) where the claim can be authorised.

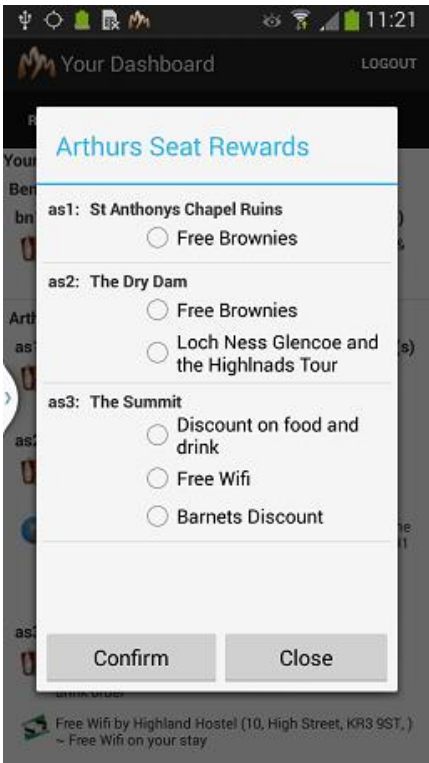


Figure 7. Rewards selection dialog box.

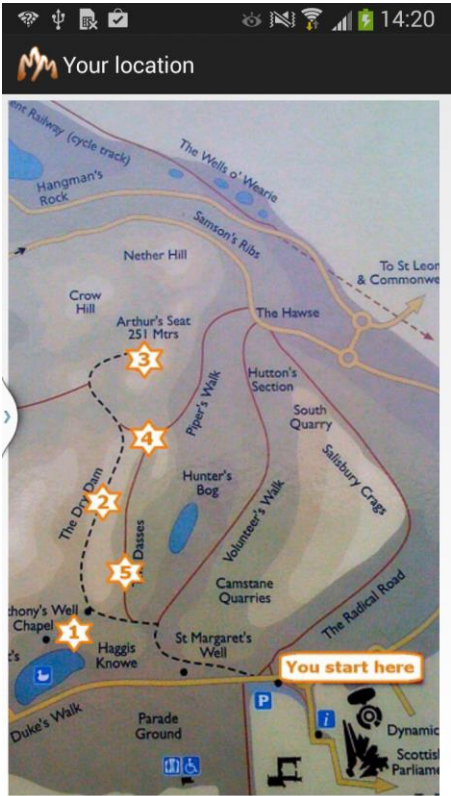


Figure 6. Map with checkpoints.

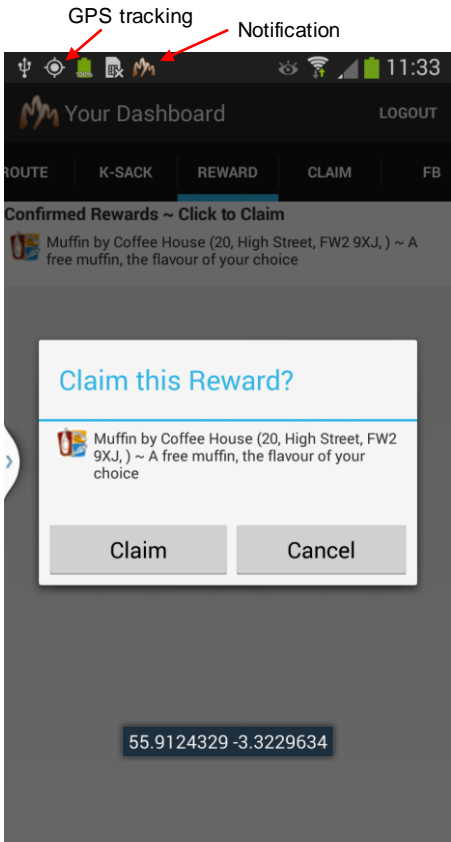


Figure 8. Claim dialog box.

Users can also post their achievements onto Facebook if they wish as illustrated in Fig. 9 allowing them to compare their progress against others en route. When they have completed the hike, they check-out by pressing the “End Route” button, which will subsequently stop checkpoints tracking and upload all the users’ progress onto the server when Internet connection is available.

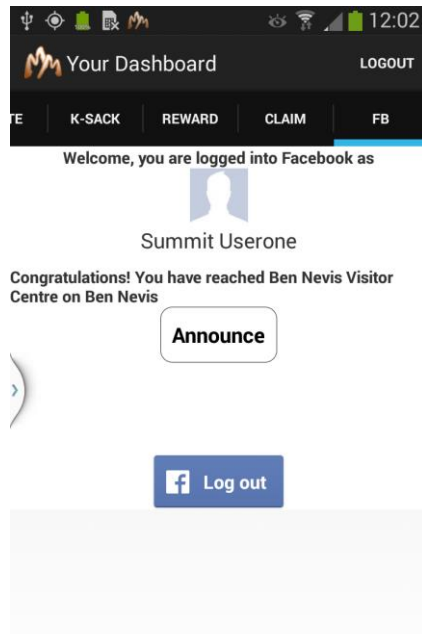


Figure 9. Facebook announcement feature.

### B. SUMMIT Web Application

The web app was developed to enable easy sign-up of local businesses as reward providers. Once registered as business users, they can perform the actions depicted in the workflow diagram in Fig. 10.

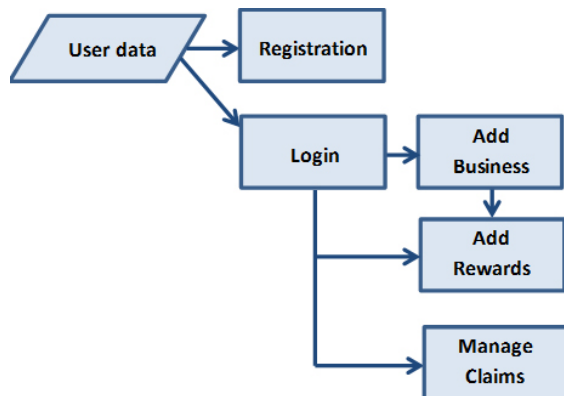


Figure 10. SUMMIT web app workflow.

The supplier can add, edit or delete a business. They can add, deactivate, re-activate, delete and edit a specific reward item. They can also approve claims from the mobile app users.

Fig. 11 shows the web app dashboard with four tabs: Your Information, Add Business, Add Rewards and Manage Claims. The “Your Information” tab displays the list of businesses and rewards owned by a provider as well as the available actions. Alert icons will appear beside reward items that reach zero count so that the provider can decide to add more of the reward or delete it.

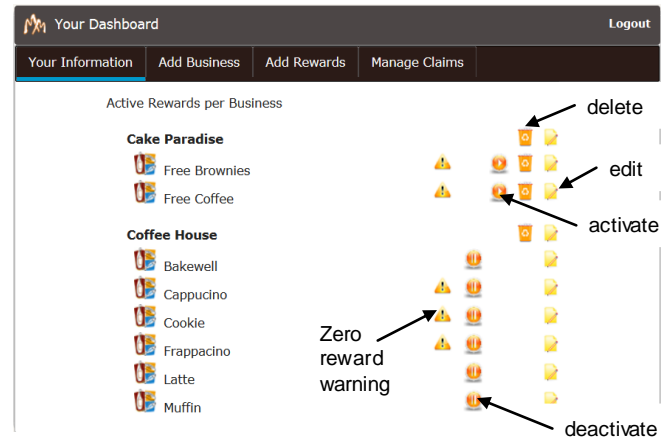


Figure 11. Web app dashboard.

The “Add Business” tab allows the suppliers to add business(es) while the “Add Reward” tab allows them to add reward(s). The “Manage Claims” tab in Fig. 12 lists all pending claims from the mobile app users. To authorise a claim from a specific user, the supplier has to click on the approve icon to the right of the claim with the respective user name.

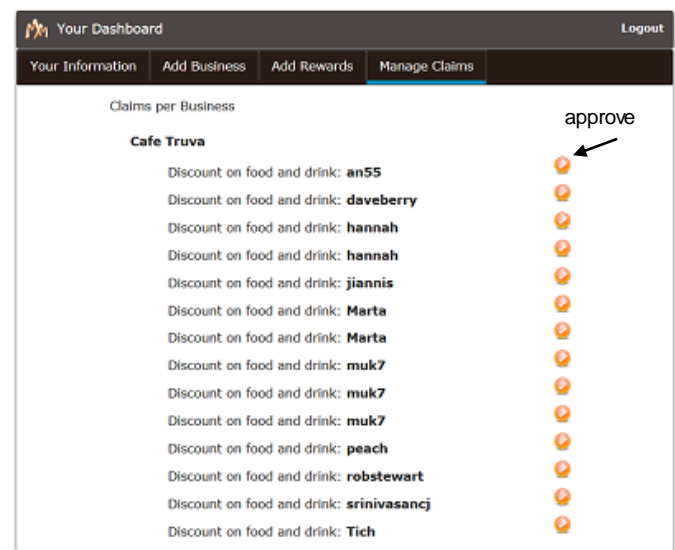


Figure 12. “Manage Claims” tab.

## V. EVALUATION

This section details the evaluation we carried out on the SUMMIT Mobile App and Web App.

### A. Experimental Setup

The experimental setups for both platforms are presented below.

#### 1) The Mobile App

A trial of the SUMMIT mobile app has been carried out with 24 participants; 18 males and 6 females. Participants were volunteers who are either interested in mobile applications or hikers and walkers. They were issued with Samsung Galaxy SIII phones with the mobile app pre-installed and were asked to hike up Arthur's Seat (Fig. 13), a popular rural area within the City of Edinburgh with many local businesses in proximity.

One of the main reasons we chose Arthur's Seat for the trial was because it is much more accessible from Heriot-Watt University making recruitment of participants easier as compared to routes around the Fort William areas such as Ben Nevis, Glen Nevis and Kinlochleven. Logistically, it is almost impossible to organise a group up north for a hike and back within a day. The unpredictable weather made the task even more difficult. On the other hand, participants can go up Arthur's Seat at their own convenience when the weather permitted anytime during the 3 weeks period of the trial.

After participants had completed the hike, they were asked to complete a questionnaire. They were asked to rate different features of the app on a 5-point Likert scale. These features included:

- S1: route information
- S2: map
- S3: rewards motivation
- S4: advance knowledge of rewards
- S5: rewards selection
- S6: claim system
- S7: rewards choices
- S8: claim intention
- S9: Facebook functionality and
- S10: ease of use of the app.

Additionally, they were given the freedom to provide further comments about any part of the mobile app or their experience of using it. Please refer to Appendix I for the full list of questions.

#### 2) The Web App

A total of 7 businesses signed up to the rewards scheme. In order to participate, the suppliers were asked to create a business account and add their own reward(s). The rewards were to remain active during the period of the trial and the following couple of months.

A week after the trial ended, they were contacted to gather their feedback on the web app. Some personal information and previous experience in using apps for advertising purposes were gathered. Other questions included the number of customers the mobile app brought

into the shops, other desired features for the web app and free comments on the web app and their experience in using it. Please refer to Appendix II for the full list of questions.



Figure 13. Arthur's Seat and part of Edinburgh's World Heritage Old Town (©OpenStreetMap contributors)

### B. Results and Discussion

In the following subsections, we present the results of our evaluation of both platforms and relevant implications are discussed.

#### 1) The Mobile App

The chart in Fig. 14 shows the overall average rating of all 24 participants. On average participants were neutral on the usefulness of the route information (S1). Taking the level of significance,  $\alpha = 0.05$ , a Mann-Whitney test on this variable between the younger (less than 40 years old,  $n=17$ ,  $M=3.418$ ,  $SD=0.425$ ) and the older (more than 40 years old,  $n=7$ ,  $M=2.286$ ,  $SD=0.694$ ) users showed a significant difference with  $U(24)=13$ ,  $Z=-3.050$ ,  $p=0.002$  (see Fig. 15).

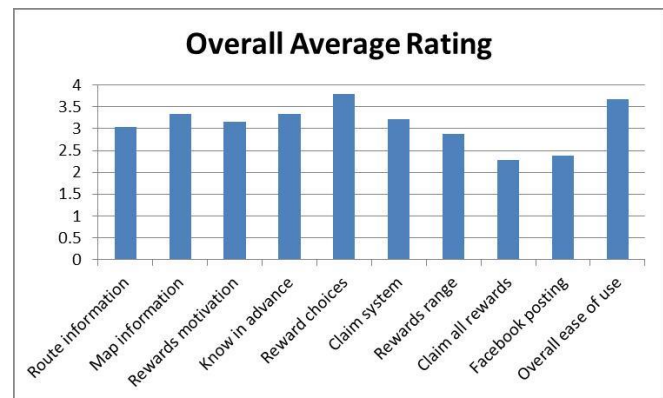


Figure 14. Overall average rating of all 24 participants.

The older generation found the route information not useful while the younger generation found it useful. This might be because the older users were used to using guidebooks when walking and were expecting directional information such as descriptions of terrain and photographs

of each checkpoint, which was not provided via the app and might have led to some of them getting lost along the way.

On average the participants found the map informative (S2). However, they would have preferred an interactive map, which tells them their position in relation to the checkpoints at any particular time instance, “a real-time blue dot” as they called it.

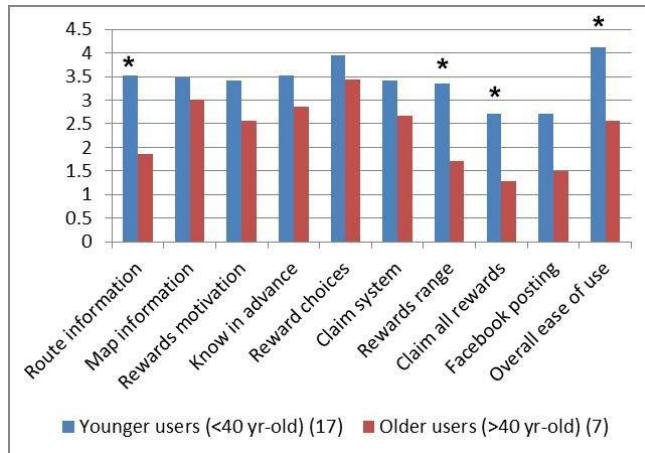


Figure 15. Average rating comparison between younger and older users. (\* denotes variables with significant differences,  $\alpha = 0.05$ )

The participants found the rewards motivated them to go on the hike (S3). Although not statistically significant, a closer look at the comparison between novice ( $n=8$ ), intermediate ( $n=11$ ) and experienced hikers ( $n=5$ ) in Fig. 16 revealed that novice and intermediate hikers found the rewards more motivating than experienced hikers. This could be due to the fact that experienced hikers have the passion to hike and thus will do it irrespective of whether they are being rewarded or not.

Some participants mentioned in their questionnaire that the rewards served as an initial motivation. As they moved from one checkpoint to another, the fact that there were rewards attached to each of the checkpoints became less important to them and, instead, their ultimate goal was to reach all the checkpoints and complete the route as reflected in the participants' comments.

*“The motivation was the challenge to reach all the checkpoints.”*

*“The biggest motivation to keep walking weren't the rewards but the challenge to reach the next checkpoint.”*

This interesting finding suggests that the gamification aspect of numbering the checkpoints itself provided enough motivation for the user to carry on once they had started. This implies that it might not be necessary to assign rewards to all checkpoints but only to a few important ones to give them the initial push.

Overall, participants thought that it was important to know the rewards in advance (S4) and to be given the option

to choose from a selection of rewards (S5). They also found the claim system easy to use (S6).

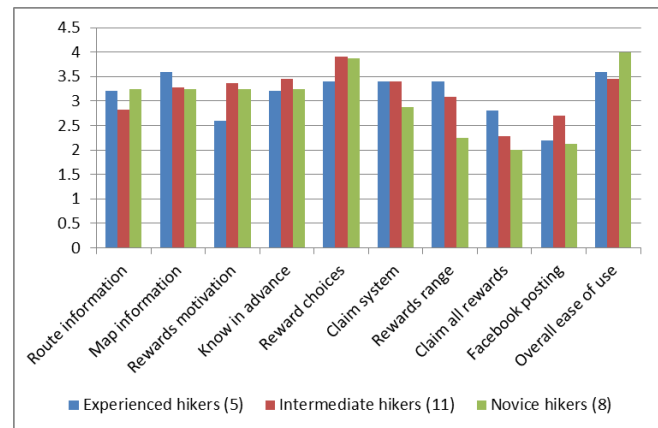


Figure 16. Average rating comparison between Experienced, Intermediate and Novice hikers.

In terms of the range of rewards provided (S7), there was again a significant difference between younger ( $n=17$ ) and older ( $n=7$ ) users. This was revealed by applying the Mann-Whitney test, with  $U(24)=17$ ,  $Z=-2.842$ ,  $p=0.005$ , to the results in Fig. 15. The younger users seemed to be satisfied with the type of rewards provided, which included discounts on food, drinks, shoes, sweets, clothes, souvenirs and tours, while the older users were not.

The older users would have liked some rewards that they could redeem immediately after the hike, for example, refreshments, discount at a local hotel or B&B and rewards targeted at kids. The younger users also mentioned that free rewards, money-off vouchers for tourist attractions such as National Trust locations, the storytelling centre, museums, zoos and castles as well as offers related to sport or physical activities would be beneficial.

The intention to claim all rewards (S8) also revealed a significant difference between the two age groups. Many of the participants were exhausted after the hike and selected their rewards only after they were home and once they were not in the vicinity of the shops. They were therefore less keen to make the effort to return to the area to collect their rewards at a later date. Their need during the short period before and after the trial may also determine whether the participants will claim their rewards, for example, discount on shoes will be useful if the participant is in need of a new pair of shoes but might be worthless otherwise. Again, the Mann-Whitney test showed a significant difference between the older and younger users,  $U(24)=21.5$ ,  $Z=-2.529$ ,  $p=0.013$ . Since the older users were less interested in the rewards, they were also less inclined to claim them.

The participants rated the ability to post their achievement onto Facebook (S9) fairly low. One reason for this might be because, as the app was only a prototype, the users had to use test user accounts instead of their own accounts. As a result the achievement posts did not appear



on their own Facebook wall or timeline. Observing the chart in Fig. 15, younger users seem to have a more positive outlook on this feature than older users although the Mann-Whitney test did not show a significant difference.

Finally, the average rating for ease of use of the app (S10) was good. However, there was again a significant difference between the older and younger users, as confirmed by the Mann-Whitney test,  $U(24)=17.5$ ,  $Z=-2.801$ ,  $p=0.005$ . This could be due to the fact that the younger users were more accustomed with mobile apps and thus had a better idea about the flow of control and operations of the app and phone in general. For example, a couple of the older participants were having some technical problems such as locating the back button on the phone and getting Facebook login to work as reflected in their comments:

*"Hardest bit was finding the 'Back' button."*

*"Couldn't get the Facebook login to work"*

Moreover, only 2 out of the 7 older participants are experienced mobile apps users while 10 out of 17 younger participants are experienced users.

The feedback on subjective questions revealed that some participants would have liked the mobile app to provide more interesting information about the route and checkpoints. One of the experienced hikers suggested that it would be useful if the app could show real-time progress such as the time he took to go from one checkpoint to another and the overall time he took to complete the route. This would allow users to compare their real-time progress with each other, hence increasing the competitive element of the app.

The mobile app has also been found to provide motivation for a second time visitor to hike a hill/mountain that they have conquered before, as one of the participants stated:

*"Thanks for giving me a reason to walk up Arthur's Seat. I am feeling revitalised and refreshed now I'm home! This serves as an excellent reason to walk up hills/mountains that you have already conquered (I've been up Arthur's Seat twice)."*

## 2) The Web App

From the perspective of the suppliers, overall they were very satisfied with the usability of the web app. The participating suppliers' age ranges from 30 to 70 and only one of them has previous experience of using an app for advertising purposes. Moreover, many of the shops have staffs working on shifts. As a result, they were not very meticulous in recording or updating the actual rewards that were redeemed in their system so we are unable to report actual numbers but we were assured that rewards were indeed claimed.

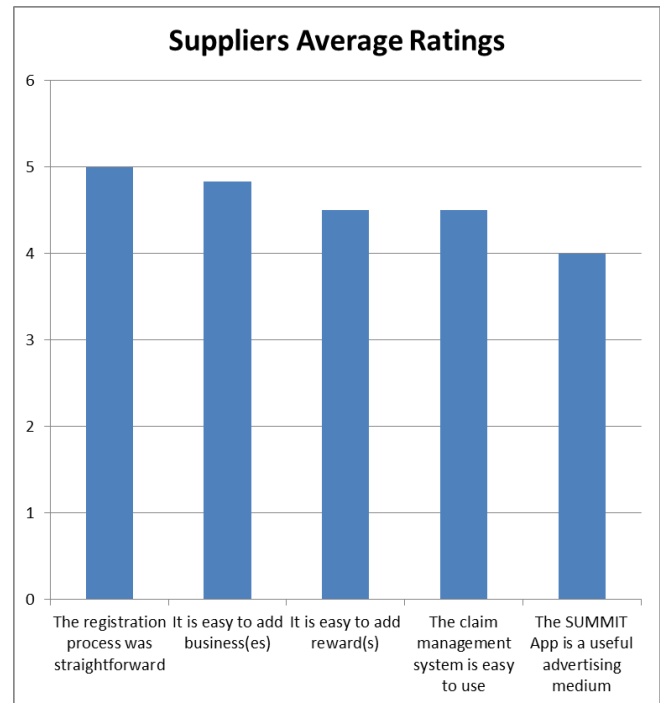


Figure 17. The average suppliers rating of different Web app features.

Observing Fig. 17, they found the registration process straightforward (S1), an average rating of 4.857 out of 5. It is also easy to add business(es) (S2) and reward(s) (S3). They found the claim management system easy to use (S4). All the suppliers who took part in the trial think that the app can potentially be a useful advertising medium (S5), hence the rating of 4 out of 5.

In order to encourage claims after the trial, one of the suppliers offered an additional deal on top of those provided on the mobile app if participants claimed within a particular period of time.

The suppliers remained very enthusiastic about the SUMMIT system following the trial. One of the suppliers suggested that it might be useful to include an online claim facility, which might encourage more claims as the participants would be able to redeem their rewards anywhere at their own convenience.

## VI. THE SCIENCE SAFARI APP

As previously stated, SUMMIT is easily extensible to new routes and attractions. Consequently, the Science Safari App [34] was created for the Explorathon'15 event [6] at RZSS Edinburgh Zoo [7] to guide visitors around the science exhibits.

### A. Explorathon '15 Event

At the Explorathon'15 event [6], visitors were invited to download the Science Safari App [34] onto their Android device when they arrived at the zoo. All available exhibits were listed on the "Route" tab and as the visitors attended each of them, the app registered the entry with notional

reward. Depending on the number of exhibits clocked, a final reward was delivered as the visitor was leaving the zoo. Various rewards were offered including sweets, pens, keyrings and badges. The “Explorer” badges personalised with name was the most popular among children.

### B. Future Potential

Successively, the Science Safari App enabled the visitor movement around the site to be captured as illustrated in Fig. 18. This information is invaluable to RZSS Edinburgh Zoo for future planning such as identifying where new services should be located and how to minimize congestion.



Figure 18. Example visitor route around the exhibits with time stamps.

RZSS Edinburgh Zoo recognises the potential of this type of technology to enhance visitors' experience and how it could be used to support its mission to engage the public in conservation issues. It already employs technology such as the Dinosaur Return App discussed earlier, online webcams (for pandas, penguins and squirrel monkeys) and the online learning system Moodle [35] through which the public can take courses in relevant subjects.

As a result, RZSS Edinburgh Zoo is exploring further with us how the reward-based gamification aspects of SUMMIT can be used to encourage and create awareness in visitors about conservation, hence fulfilling its aims of providing recreational and educational value to visitors.

In order to realise this potential, the first step would be to capture the visitor flow with a much larger monitoring programme using portable device such as suitably located RFID reader while issuing each visitors with RFID labels, which permit both indoor and outdoor tracking. The data gathered will then be mined to identify pattern for daily and seasonal variations. The rewards may then be assigned to

less “popular” locations or where important messages on conservation are being delivered.

Additionally, to maximize the visitors learning experience, delivery of meaningful and coherent content is crucial. Visitors usually determine their own routes around different points of interests and this variability can make it difficult to deliver understandable content to them. A way to overcome this is by recording movement history as visitors traverse the zoo and alert them to other related exhibits based on this information. We have developed such solutions in a number of previous projects [36, 37, 38, 39].

A further novel information delivery approach in which content is personalised and adapted to a visitor's prior knowledge based on what they have already received would avoid the annoying repetition common to current information delivery systems. This will provide visitors with unique narratives and experiences evolving around their own interests and knowledge.

The opportunity to deploy and test these ideas in a public setting such as RZSS Edinburgh Zoo will enable us to further our research in this field.

## VII. FUTURE WORK

In its current state, the SUMMIT Mobile app is easily extensible to other locations by adding new routes information and checkpoints coordinates. However, there are still room for improvement which could further the potential of the app.

- It would be beneficial to include an interactive map that dynamically updates the user's position on the map during the hike, for example a real-time ‘blue dot’ that tracks the user on the map.
- To increase cultural appreciation, the app can take advantage of attractions along a certain route and uses these as checkpoints. This will encourage visitors to make diversions and visit places that they might not be visiting when they do the usual hike. The user experience and engagement can also be improved if the app can provide the users with interesting and meaningful information about these locations.
- To target users of all ages, the app may benefit from a wider range of rewards with greater intrinsic values for example useful information about the local area, discounts on tickets for local events or entrance to local attractions and offers related to sports or physical activities available in the local area.
- It might also be useful to personalise the rewards according to age group or type of users so that their needs are better met as suggested by the focus group.

- It would be worthwhile to grade the route with different level of difficulty so that the user can choose routes that are suited to their capability reducing the possibility of struggles or lose of interests.
- Information regarding personal progress can be valuable for some users who are interested in how they are performing such as the overall completion time and the time taken to go from one checkpoint to another.
- Presentation of personalised and coherent information based on users' prior knowledge will increase engagement and improve recreational and educational experiences.

An improvement to the SUMMIT Web app would be the inclusion of an online claim facility which allows the user to make the claim online without the need to physically visit the shops. This might benefit hikers who travel through regions that take hours or days. However, this will work only for intangible rewards or rewards that can be sent through post. This will also encourage the participation of more businesses as the constraint of location is eliminated. Care has to be taken to ensure that priorities are still given to local businesses in the target area.

A larger scale evaluation at the Fort William area will provide us with more insights about users' perception and experiences of the apps.

### VIII. CONCLUSION

SUMMIT has successfully added the elements of social fun and motivation to walking and hiking activities. It helps to promote local resources around a route by making users aware of their existence through its rewards scheme and checkpoints assignment. Business users were satisfied with its ease of use and appreciated its potential as a useful medium for advertising and delivering their wares and services. Its application in a public "in-the-wild" setting at RZSS Edinburgh Zoo has also proved successful and demonstrated the potential of such technology in improving visitor experiences and education.

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## Appendix I: SUMMIT Android App User Trial Questionnaire

### About You

Username : \_\_\_\_\_

Age : \_\_\_\_\_

Gender : male female

Prior experience with mobile apps:  
novice intermediate experienced

Hiking experience :  
novice intermediate experienced

How often do you go on hiking trips? \_\_\_\_\_

### About SUMMIT Android App

Please rate your degree of agreement with the following statements: From Disagree (1) to Agree (5)

- 1) The route information was useful
- 2) The map was informative
- 3) The rewards motivate me to continue hiking
- 4) It is important to know what rewards are available in advance
- 5) It is important to be given some choices of rewards to select from
- 6) The reward claim system was easy to use
- 7) I found the rewards useful
- 8) I intend to claim all the rewards I have chosen
- 9) I found the ability to post my achievements onto Facebook useful
- 10) Overall, the SUMMIT Android App was easy to use

What other type of reward would you like to be included?

Other comments

## Appendix II: SUMMIT Web App User Trial Questionnaire

### About You

Age : \_\_\_\_\_

Type of business : \_\_\_\_\_

Have you used any app for advertising purposes before? :  
Yes No

### About SUMMIT Web App

Please rate your degree of agreement with the following statements: From Disagree (1) to Agree (5)

The registration process was straightforward

It is easy to add business(es)

It is easy to add reward(s)

The claim management system is easy to use

The SUMMIT App is a useful advertising medium

Did the SUMMIT app bring you customers? If yes, how many?

What other features would you like the app to provide?

Other comments