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Developing A Gamified Contributory Platform For Up-To-Date Geo-Data Provision In Nigeria

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Abstract: ***The need for an up-to-date and accurate map for the development of Nigeria cannot be overemphasized with the many advantages it offers. OpenStreetMap is an initiative that does not need the involvement of the government and the mapping is crowdsourced by volunteers, thereby reducing cost and time of completion to the barest minimum and also increasing coverage. The Nigeria map on OpenStreetMap is not up-to-date because crowdsourcing awareness is still quite low and unexplored in Nigeria. This brought about the need to design and implement an application that motivates, and sources for the crowd (volunteers) to develop an opensource map for Nigeria. This research introduces gamification as a practical technique to motivate and improve participation in crowdsourced applications, especially in mapping the country. Firstly, this work carried out an online survey of users' opinions about game mechanics and OpenStreetMap to investigate user acceptance of the concept. A gamified crowdsourcing application called IsoKan was developed using a gamification reward model for Nigeria mapping. IsoKan was developed for routing new roads, validating geo-data such as the name of the road, and verifying existing map geo-information. The result shows a 30% of users' preference of the developed app over the Kort and Foursquare apps, and analysis of administered questionnaires indicates that users will be motivated with the use of gamification in the application.***

Keywords: Gamification, Crowdsourcing, OpenStreetMap, Map, Nigeria, location-based

I. INTRODUCTION

Maps are one of the world's oldest types of documents and means of communication [1], they are common objects, seen and referred to very often. A map represents geographic features or other spatial phenomena by graphically conveying information about locations and attributes. The locational information in a map describes the position of particular geographic features on the Earth's surface, as well as the spatial relationship between features. While the attribute information describes characteristics of the geographic features represented, such as the feature type, its name, or number, and quantitative information such as its area or length [2]. Despite the importance of maps, Nigerian maps are not up-to-date and accurate because of some factors which are; rapid geographic development and growth, report updates not getting to the map makers, cost of mapping, the time it takes to map, etc.

Due to inaccuracy in maps crowdsourcing of maps was employed. According to Jeff Howe in 2006 crowdsourcing is a means of inviting a large group of people to cooperatively tackle a big problem. Crowdsourcing is also known as collective intelligence. A term originally coined by French philosopher Pierre Levy in 1994 to describe the impact of Internet technologies on the cultural production and consumption of knowledge. Levy argued that because the Internet facilitates a rapid, open, and global exchange of data and ideas, over time the network should "mobilize and coordinate the intelligence, experience, skills, wisdom, and imagination of humanity" in new and unexpected ways [3]. Most crowdsourcing application utilizes gamification principles to entice users to curate and publish regular content while holding the community (and its content) responsible for

accuracy and quality [4]. Gamification is the concept of applying game mechanics and game design techniques to engage and motivate people to achieve their goals. Gamification taps into the basic desires and needs of the users' impulses which revolve around the idea of Status and Achievement [5].

While different crowdsourcing application utilizes a wide-range of gamification principles at varying degrees (and with differing success), the decision to implement gamification mechanics depends on the quality of experience the project seeks to offer based on the understanding of their users' drives and motivations. In some cases, people may be naturally inspired to contribute their time and efforts towards a particular cause (e.g. Wikipedia) this is known as intrinsic motivation, and in other instances, it may be beneficial to enhance the experience of the crowdsourced endeavour by making it more immersive and compelling through the integration of key game mechanics [6] also known as extrinsic motivation.

Gamification techniques strive to leverage people's natural desires for competition, achievement, status, altruism, community collaboration, and many more. Businesses can use gamification to drive desired user behaviours that are advantageous to their brand [7]. One common technique of gamification is to increase engagement by rewarding users who accomplish desired tasks. Rewards such as badges and points are used to elevate status by showcasing the talents, expertise, and accomplishments of users [8]. Competition is another technique that can be used in gamification. The desire to appear on the leader board drives players to complete more tasks in fueling deeper engagement [7].

In this paper IsoKan application is presented, it applies gamification techniques to persuade users to contribute their amendments to Nigeria's map. The goal is for citizens to amend well-known place names while playing a game. This approach of gamification motivates users by turning a demanding and repetitive task into an engaging and enjoyable one. From the users' point of view, they will be playing a game while contributing to the Nigeria map and also given chance to route a new location not existing before on the map. A review of the related literature is presented in Section II. Section III presents the methodology of the work, Sections IV and V talks about the implementation, and system testing and results from analysis respectively, while Section VI further discussed experimental results and section VII concludes the paper and discusses further research works.

II. REVIEW OF RELATED LITERATURE

In this section, a brief outline is given based on the related work in the area of gamification, crowdsourcing, human computation games, and effective crowdsourcing. In the last few years, crowdsourcing and gamification techniques have been used in many projects to obtain geospatial data. In the Rise of Crowdsourcing [10], Howe explains that the evolution of technology (Web 2.0) allows us to present a problem to a crowd of people and get a satisfactory solution, in many cases, better than hiring an outside company.

The work of Ushahidi was reported [11], a crowd map was developed as a simple map-making tool, built on an open API that allows collaborative mapping of the world. It allows collections of information from cell phones, news, and the web, aggregate the information into a single platform, and visualize it on a map and timeline. Foursquare service was created in late 2008 and launched in 2009 by Dennis Crowley and Naveen Selvadurai [12]. Foursquare is the largest location-based social networking (LBSN) with nearly 30 million users of which more than four million check in every day. A free app that helps people to make the most of where they are.

Waze is a free social mobile application that provides turn-by-turn information and for users to submit travel times and route details, and to provide downloading location-dependent information over the mobile telephone network that uses real-time input from motorists to update traffic conditions for other users by using GPS-enabled smartphones with a data plan. It was developed by the Israeli start-up Waze Mobile, which was acquired by Google in 2013. Kort is a web service optimized for mobile phones to create a mobile web app for main mobile platforms: iOS, Android, etc. for correcting OpenStreetMap data that combines the concept of gamification with volunteered geographic information and is targeted to non-specialists [13]. This game was developed by Stefan Oderbolz and Jürg Hunziker at the University of Applied Sciences, Rapperswil, Switzerland. Gamified crowdsourcing applications have been widely used in different scenarios, most often in the learning and business environment. Gamified crowdsourcing application is for enhancing engagement, brand awareness, and potential loyalty through supporting a behavioural shift towards the desired objective [9].

This research presents the design of the gamified crowdsourcing application and database that serves as its backend. It also entails the formulation of the required model for the research work.

III. METHODOLOGY

Considering a crowdsourcing system that categorizes tasks into k types, it contains two types of tasks ranging from "mapping to locating the point of interest". Users of a crowdsourcing system are classified into requesters and workers. A user can be a requester or a worker, or in some cases, a requester and worker at the same time. Requesters outsource tasks to a crowdsourcing system and at the same time, associate each type k task with a reward of rk, k∈ {1, . . ., K}; the reward rk was granted to the workers who make contributions to the corresponding task.

A task is assigned to only one worker. Capturing the scenario that a task requires many workers, in which the task can be divided into many copies and each copy requires one worker. A worker can exert a level of effort $L \geq 2$ where $L = \{1, \ldots, L\}$ in solving a task, which results in L levels of contribution $CL = \{C1, \ldots, CL\}$. Assuming that $CL > CL-1 >, \ldots, > C1$, where $Ci > Cj$ represents that contribution Ci is higher than Cj. For ease of presentation, {C1, . . . , CL} denotes action set for workers. When a worker acts with Ci, it

implies the worker exerts the ith level of effort to solve the task. The cost in making a Cj contribution to a task is denoted as cj, where cL>cL−1>, . . ., >c1=0. For a task, if a worker exerts Cj to provide a solution, then it brings a benefit of Vj to a requester, where VL >VL−1>, . . .,>V1 =0. Again, V1 = 0 because c1 = 0. VL > r+K is required, which induces incentives for requesters to participate. The work also shows how to incentivize workers to exert CL, the highest possible contribution.

A. INFORMATION REQUIRED FROM THE CROWD

Developing a gamified crowdsourcing app platform targeting audiences between the ages of 16-60 years. The frontend was in Javascript, HTML5, and CSS3, and the backend in ASP.NET. The gamified crowdsourcing app was divided into two parts: mapping and locating the point of interest which are explained in this section.

a. MAPPING

Users can correct, create a new road, or add additional features that existed in their environment but not on the map on an existing map extracted from OpenStreetMap. This is carried out by drawing lines, polygons, and adding features that existed in their environments with the help of geographical positioning system (GPS) routing in the application, and for every correction that is made, they are rewarded.

b. LOCATING POINT OF INTEREST

The user can play by answering questions concerning the mapped area on the map, and for each question answered, a reward is given. No matter the area the user picked to be the location, the reward is given, there is no right or wrong answer. The volunteer will still have a reward for participating. For every located area on the map, the results will be stored in the app's database.

Answers to these two questions on mapping and locating points of interest are retrieved from the crowd by them answering the following questions:

- ✓ What area is this? For this question, graphical pictures of an environment will be given to the user to identify and the user will have to locate where they are in real life on the map. For locating the area on the map rewards are given to users.
- ✓ Where the particular object is located? For this question, graphical objects pictures like higher institution signposts, hospitals signposts, popular markets, etc., will be displayed for the user to give their location on the map.
- ✓ Which area can this be found? For this question, graphical images of railways, seaports, airports will be displayed for the user to give their location on the map.
- ✓ What is the speed limit on this road? For this question, an area of interest on the map can be zoomed to see the roads, and an icon will pop up, once the icon is clicked the question will be asked. The answer expected to be given looks like this (10, 20, 30, etc.). For answering the question reward will be given.
- ✓ Is this road a highway road? For this question, an area of interest on the map will be zoomed to see the roads, an icon will pop up, once the icon is clicked the question will be asked, and the answer for this stage will be (yes or no).
- ✓ Where is this place located? For this question, an area of interest on the map will be zoom and graphical pictures of historical places like museums, tourist centres, palaces, etc., will be located on the map.

B. MOTIVATING CROWD PARTICIPATION

The app is not intended to be implemented as a conventional editor, but a certain Game in character. This is characterized by the fact that the users for every amendment alteration, proposals will be rewarded. They can be awarded points for example, in the ranking (high score), and crown.

Every reward collected by every user reflects on the leaderboard in ascending order, therefore it creates room for competition to be on top of the leader. This allows users to play more, and more information is received.

Gamification model consisting of the following four components (Michael & Brijnesh-Johannes, 2014):

- ✓ A task K needs to be performed.
- ✓ A set of game design elements g ∈ G, where G is gamification.
- ✓ A set of users u ∈ U processing task K enhanced by G, where U is the total number of users.
- ✓ A task-dependent ground truth f∗ : U → G

A function class F consisting of the function of form f: U → G.

C. RELIABILITY CHECK AND PERFORMANCE EVALUATION OF APPLICATION

The reliability check is based on the highest number of the same answers per question from different people. Each question in the app is a task to be completed, and there are several tasks in a level which are picked at random from all questions (tasks) that are available when all tasks in a level are completed then the user receives a point, and the user moves to another level.

D. CHOICE OF GAME ELEMENTS

With the number of numerous game-elements available in gamification, it is essential to identify the one that can assist in the stated objectives of the project. The resulting analysis of the questionnaire helps to indicate the age range of the respondents and how often the targeted respondents use the internet. In a gamified system, the ability of participants to collaborate with other participants in a community setting towards the pursuit of common goals presents a statistically significant difference in the experienced fun. The questionnaire analysis helps to know what targeted respondents' common interest is and was incorporated into the gamified crowdsourcing application, some of which were:

- ✓ It helps to know if the gamified crowdsourcing application should be based on the internet and the medium audience currently like playing their game which

is via Tablet, phone, and Computer. This makes the application to be both mobile and web-based.
- ✓ It helps to know the game activities, rewards, features, and genres played by the audience which was incorporated in the gamified crowdsourcing application.
- ✓ It helps to know the level of people's awareness of gamified crowdsourcing appraisals, and the willingness of the targeted crowd to be involved in the gamified app.

A survey on game information was carried out in the form of a questionnaire using Google form. The questionnaire was administered to know for instance the types of genres played, game rewards people prefer, game activities and features people like, how often people play the game and access the internet, how long people play the game, people understanding about OSM, and to the willingness of people to help update the map. Microsoft Excel was used to analyze the questionnaire and display data as histograms and charts and the following results were obtained.

a. QUESTIONNAIRE ANALYSIS

There were 94 respondents with an average age of 27 years and they were all familiar with the usage of the internet, 69% of the respondents are male. Respondents between the ages of 26-35 years are the most users of the internet. 86.17% of the respondents access the internet multiple times a day, 10.64% of the respondents access the internet multiple times a week, while 3.19% of the respondents access the internet multiple times a month.

57.45% of the respondents preferred to play games alone while 42.55% of the respondents preferred to play games with a friend(s). The result shows that the majority of the respondents preferred to play games alone.77.66% of the respondents do not play online multiplayer games while 22.34% of the respondents do play online multiplayer games. The result shows that the majority of the respondents do not play online multiplayer games. The result shows that respondents enjoyed a game for 1-2 hours before moving to another game.

30.85% of the respondents play the game every day, 17.02% of the respondents play game 1-2 times a week, 14.89% of the respondents play game 3-4 times a week, 7.45% of the respondents play game 5-6 times a week, 11.70% of the respondents play game 1-3 times every month, 4.26% of the respondents play a game every couple of months, 11.70% of the respondents play the game less often while 2.13% of the respondents never play the game. The result shows that the majority of the respondents' play games every day.

On the demographics of respondents, the male gender who were between 26-35years of age, are expert users responded quickly more based on above-average percentage ratings. They accessed the internet multiple times a day alone without having friends as a multiplayer. Most respondents enjoy a game for an average of 1-2 hours before moving to another type of game and they play games every day. Respondents appreciated graphics more than gameplay, user interface, and mental challenges. Regarding achievements i.e., completing goals was one of the best activities respondents like in their games, while points and levels were their favourite game reward system. The genre of games played most by respondents were sports and educational based while some considerable percentage went for adventure and simulation games. Respondents have shifted focus from traditional platforms where games are played manually, they currently enjoy having their games deployed on either phone, laptops, tablets, or Xbox in descending order.

After successful completion of the questionnaire analysis and design of appraisal questions, the gamified appraisal section is next. The system design, rules guiding the application usage is stated out here clearly.

E. MOBILE APPLICATION DEVELOPMENT

The application developed has different features such as:
- ✓ Provides a motivational interface.
- ✓ Extracts Nigeria Geo-data from OpenStreetMap (OSM)
- ✓ Provides Edit Capabilities to Geo-data
- ✓ Save edited Geo-data (in the correct format)
- ✓ Ability to view the up-to-date map

a. EXTRACTION OF NIGERIA GEO-DATA FROM OSM

In the course of the research, Nigeria Geo-data was extracted from the OpenStreetMap using websites such as "Geofabrik" and "Cloudmade" which offer free downloadable OpenStreetMap data in different formats such as XML and Shapefile, and then the desired urban zone was clipped.

An HTML5 web application was developed which allows completely mapping correctly or correcting erroneous data in the OpenStreetMap database.

b. SAVING EDITED GEO-DATA

The questions cater for locating areas and objects on the map, validating the speed limit on the map and highways on the map, and locating historical places on the map. For every located area, data collected by answering questions are stored in the app database and are sent to the KeepRight database that analyses it and makes the necessary correction on the OpenStreetMap

IV. SYSTEM IMPLEMENTATIION

The purpose of the implementation phase is to translate the software design into source code. Each component of the design is implemented as a program module. The end-product of this phase is a set of program modules that have been individually tested. Each module is unit tested to determine the correct working of all the individual modules. It involved testing each module in isolation as this is the most efficient way to debug the error identified at this stage.

Figure 1 presents the architectural design for implementation. In this phase, the system design depicted in the form of a diagram and model in chapter three is converted into tangible software by coding. All program code is implemented using C# (pronounced 'C-sharp') Asp.Net and JavaScript programming language a Microsoft-oriented language. System components shown in the system

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architecture in chapter three earlier are implemented one after the other in an object-oriented fashion. Other tools employed during the implementation phase include; Microsoft Visual Studio 2010- Integrated Development Environment

Microsoft SQL Server 2012 – Database Management System

Mapbox Studio- Open-Source map design Platform

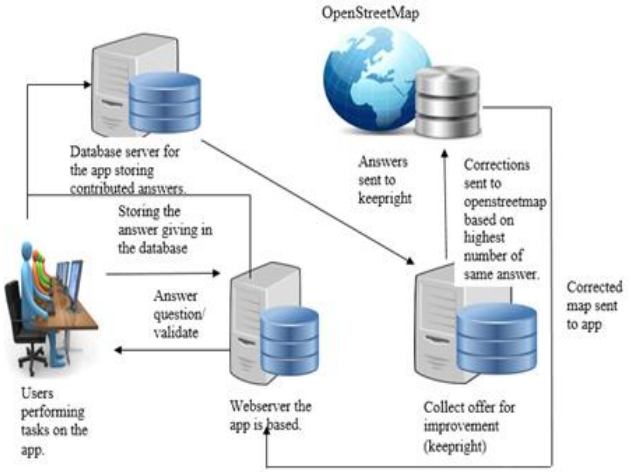

Figure 1: Architectural design for Implementation

V. SYSTEM TESTING AND RESULTS

After the system has been completed and all components unit testing is done with, the different modules or components are integrated in a planned manner. The integration was carried out incrementally over several steps. During each integration step, the partially integrated system is tested and a set of previously tested modules are added to it. Finally, when all the modules have been successfully integrated and tested complete system testing was carried out. The system testing helped ensure requirement and design conformance. The kind of system testing carried out is α-testing (i.e. testing performed by the development team). The minimum Phone requirements to run the application; Android 4.0, 512 of RAM or higher and no system requirement for components, only requires an internet connection and a browser. Some tasks or transactions are identified and a series of steps detailing how to accomplish them are explained.

A. WELCOME PAGE

The welcome page appears when the application is launched. This is shown in figures 2 and 3. It contains the play game icon that leads to the map, track list icon that leads to routing with GPS, quit icon to close the application, and the menu icon it helps to know where to navigate.

Figure 2: Page showing application menus

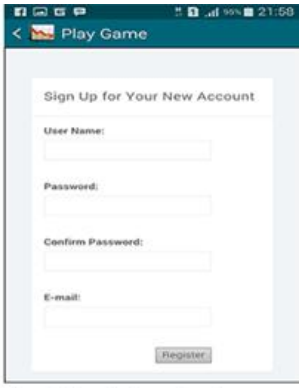

Figure 3: Page showing registration.

B. REGISTRATION AND LOGIN PAGE

The registration page is the page where the player information is being registered It contains the name, password, password confirmation, and Email address as shown in figures 4 and 5. The login is where the registered members enter their login details (Username and Password) to gain full access to the IsoKan App.

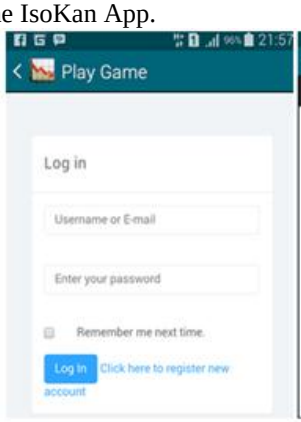

Figure 4: Login page for IsoKan App

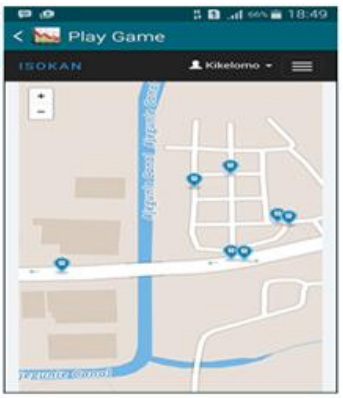

Figure 5: Map Page

C. MAP, QUESTION (TASK), AND ANSWER PAGE

On the homepage, when the play game icon is clicked it navigates to the map page where there are the map of Nigeria, and questions (tasks) for validating the existed map (shown in figures 6 and 7). Clicking on the blue maker navigate to the question page, question (task) to be completed pops out with the picture of the area where applicable. This is where the answer to each question (task) is given and a reward for each is given.

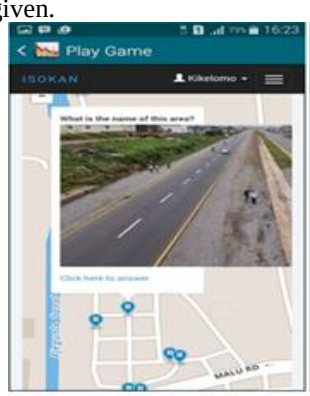

Figure 6. Question Page

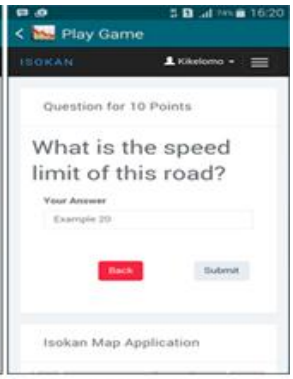

Figure 7. Answer Page

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D. INFORMATION PAGE AND GPS ENABLE PAGE

The information page provides information about the map (OSM), the high score (i.e the leaderboard), how to play the game, Badges available, about the app (IsoKan), the current level of the player (which can be beginner, Amateur, intermediate, professional and expert), number of the completed task (mission) and the total number of points earned. The GPS enables page gives information about the GPS once it is disabled and automatically enables it when the instruction is given as seen in figures 8 and 9.

Figure 8. Information Page

Figure 9. GPS enable page

E. TRACK LIST PAGE

The tracklist page shows all the recorded tracks (routes) by the GPS. The tracklist detail page provides detailed information about every routing, the start and end time, the start and end position, the longitude and latitude of tags and a description of the route tracked (shown in Figures 10 and 11).

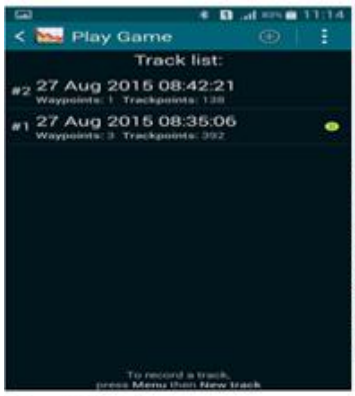

Figure 10. Tracklist page

Figure 11. Tracklist detail page

F. POINT OF INTEREST MENU PAGE

The point of interest menu page (figure 12) provides a link to a voice recorder (figure 13) that can take vocal description and information of an area, taking pictures of the area, taking information in form of text note, miscellaneous, restriction area, car, tourism attraction, amenity, way, tracks, and land use during GPS tracking (routing).

Figure 12. Point of interest menu page

Figure 13. Voice Recording.

G. MISCELLANEOUS AND CAR PAGE

The miscellaneous page contains points of interest such as bus stop, railway, telephone, post box, ATM, bollard, toilets, and shelter surveillance that can be tagged to a location during GPS tracking (routing). The restriction page contains the point of interest for traffic rules such as speed limit signs, no exit signs, traffic light signs, and a one-way sign that can be a tag to a location during GPS tracking (routing) (figures 14 and 15). The car page contains points of interest such as fuel station, parking lot, emergency phone, turning circle (roundabout), and speed camera that can be tagged to a location during GPS tracking (routing). These are shown in figures 16 – 18.

Figure 14. Taking Picture

Figure 15. Text Note

Figure 16. MISC page

Figure 17. Restriction Page

Figure 18. Car Page

H. TOURISM PAGE, AMENITY PAGE, AND AMENITY (+) PAGE

The tourism page contains points of interest such as viewpoint, information about location, picnic site, attraction, theme park, castle, monument, museum, and cinema that can be a tag to a location during GPS tracking (routing). Amenity

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page contains points of interest such as bench, water, pharmacy, shop, marina, sport, taxi, hospital, doctors, recycling, place of worship, post office, and library that can be a tag to a location during GPS tracking (routing). Amenity (+) page contains points of interest such as school, police station, fire station, bank, playground, pub, hotel, motel, hostel, restaurant, fast food, and campsite that can be a tag to a location during GPS tracking (routing). Tourism Page, Amenity Page, and Amenity (+) Page are shown in Figures 19 - 21.

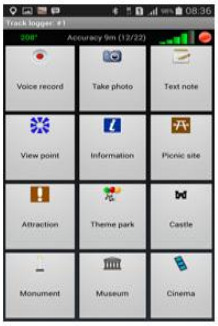

Figure 19. Tourism Page

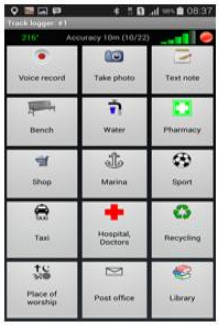

Figure 20. Amenity Page

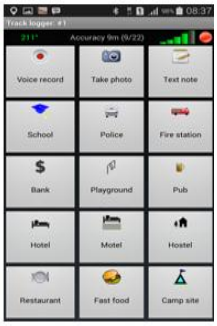

Figure 21. Amenity (+) Page

I. WAY PAGE, LAND USE PAGE, AND RECORD-ROUTE PAGE

Way page contains points of interest such as bridge, zebra crossing, motorway, trunk, primary, secondary, tertiary, residential, and service way that can be a tag to a location during GPS tracking (routing). The land use page contains points of interest such as farm, landfill, basin, reservoir, forest, allotment cemetery, and recreation ground that can be a tag to a location during GPS tracking (routing). Record route page, once the page is launched user routes start recording which will be saved in the app database. Figures 22 -24 show the Way Page, Land use page, and Record-Route Page.


Figure 22. Way Page


Figure 23. Land Use Page

Figure 24. Record-Route Page

VI. EXPERIMENTAL RESULTS

During testing the application, the Federal University of Technology Akure well-detailed roads were tracked and recorded the point of interest such departments, lecture halls, school library, and so on were attached to it and the result was sent to OpenStreetMap (OSM) to effect the changes. Figure 25 shows a little part of the road network.

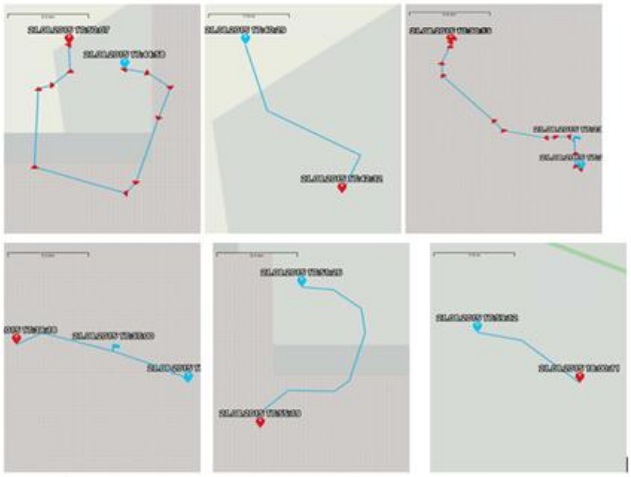
Figure 25. A little part of the road network

The maps were joined together and Figure 26 shows the result with the point of interest attached.

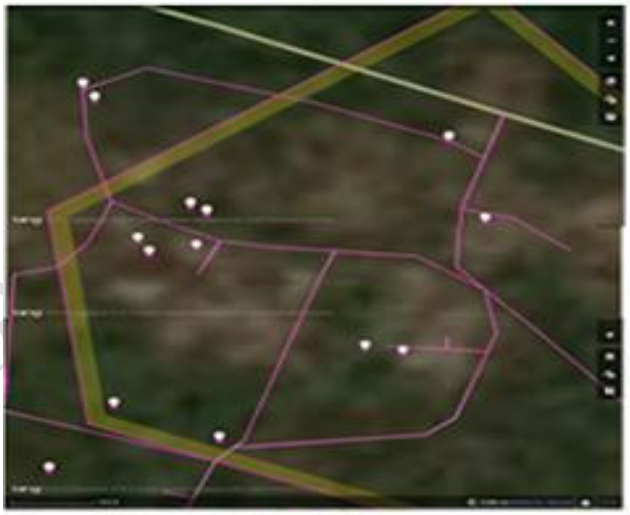
Figure 26. Result of point of Interest

VII. CONCLUSION

In this research, a gamified crowdsourcing application that is compatible and incorporated into OpenStreetMap to assist in mapping Nigeria was developed. The application has been used for validating existing maps and also to record new tracks which were submitted to OpenStreetMap. This application was programmed using C# (pronounced 'C-sharp') Asp.Net and JavaScript programming language a Microsoft-oriented language. It is recommended that the government can make use of this application to source for crowds to do the mapping in less time. Future research can consider factors like making the gamified crowdsourced app more dynamic and adventurous.

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