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DEVELOPMENT OF FACILITATED PARTICIPATORY SPATIAL INFORMATION SYSTEM FOR SELECTED URBAN MANAGEMENT SERVICES

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ABSTRACT

In this paper, the development of a web based spatial information system for selected urban management services in Akwa Ibom state is presented. The selected urban management services include; disaster management, waste management, land administration and land transportation information hub. Participatory evolutionary software development methodology was used in the system development and the system was implemented using Hyper Text Markup Language (HTML) for the web interface, PHP Hypertext preprocessor (PHP) for the server side scripting , MySQL for the database, Google map API (Application Programming Interface) for the maps and Apache as the web server. The web application was hosted locally using WAMP server and tested with some dataset obtained in the case study area. Relevant screenshots of the webpages are also presented. The web application presented in this paper can be used to facilitate participatory urban service in any given city or state.

Contribution/Originality: This study originates requisite flowcharts and accompanying web applications for online management of selected urban services. Notably, the software designs are based on the prevailing technical and socioeconomic conditions in the case study area (Akwa Ibom State Nigeria).

1. INTRODUCTION

Nowadays, the advancement and convergence of spatial data capturing technologies such as satellite remote sensing technology and free web-based mapping technologies and services have given rise to the wide-spread application of Spatial Information System (SIS). SIS is a family of information system that is designed specifically to manage the collection, manipulation and visualization geographically referenced data [1-4]. Notably, SIS is now used in many fields such as environmental control, tourism, resource management, marine resource planning, scientific paper and urban management [5-9]. In this paper, SIS is developed for selected urban management services. Urban management refers to policies, plans, programs and practice put in place to build fair, governable and sustainable city [10-12]. Urban management services make urban cities conducive for the inhabitants and easy to implement development projects [13-15]. Planning is a core part of urban management that consists of the following processes: information gathering and analysis; development of a logical alternative course of action that is consistent with the goal of the region in view; and recommendation of a course of action. Information collection, management and analysis of past trends and present issues are pre-requisite of good urban planning and management [16-18]. In this paper, a facilitated participatory spatial information system for selected urban management service is proposed. In this context, spatial information system is defined as a web-based platform that

consists of data, people, communication network, standards, protocol, organizational framework and other elements required to facilitate timely and effective access to spatial information. The intention is to offer a coordinated spatial information management facility that will support a number of selected urban management services along with diverse stakeholders both in the private and public sector as well as members of the public. Specifically, the urban management services that are considered in this paper are disaster management, waste management, land administration and land transportation information hub. The system will provide a platform where stakeholders and the public can access and update information about disaster, refuse disposal, land information and land transport services in the city. Participatory Evolutionary Software Development Methodology (PESDM) is used. PESDM allow the system modules to be implemented iteratively, with an active participation of the stakeholders throughout the entire development process. The phases involved in PESDM model are software requirement engineering, planning, designing, implementation, testing and deployment. The technologies used to implement the system are PHP Hypertext preprocessor (PHP) for the server-side scripting, Hypertext Markup Language (HTML) for the web interface, MySQL for the database, Google map API (Application Programming Interface) for the maps and Apache as the web server [19-21].

2. THE SYSTEM DEVELOPMENT METHODOLOGY

The software engineering methodology employed in this paper is a Participatory Evolutionary Software Development Methodology (PESDM) shown in Figure 1. In the system design, functional decomposition technique is used as depicted in Figure 2. Particularly, top-down stepwise refinement approach is used in the functional decomposition process. Through the functional decomposition process, the modules and submodules that make up the entire system are identified and their logical connections are identified, as depicted in Figure 2.
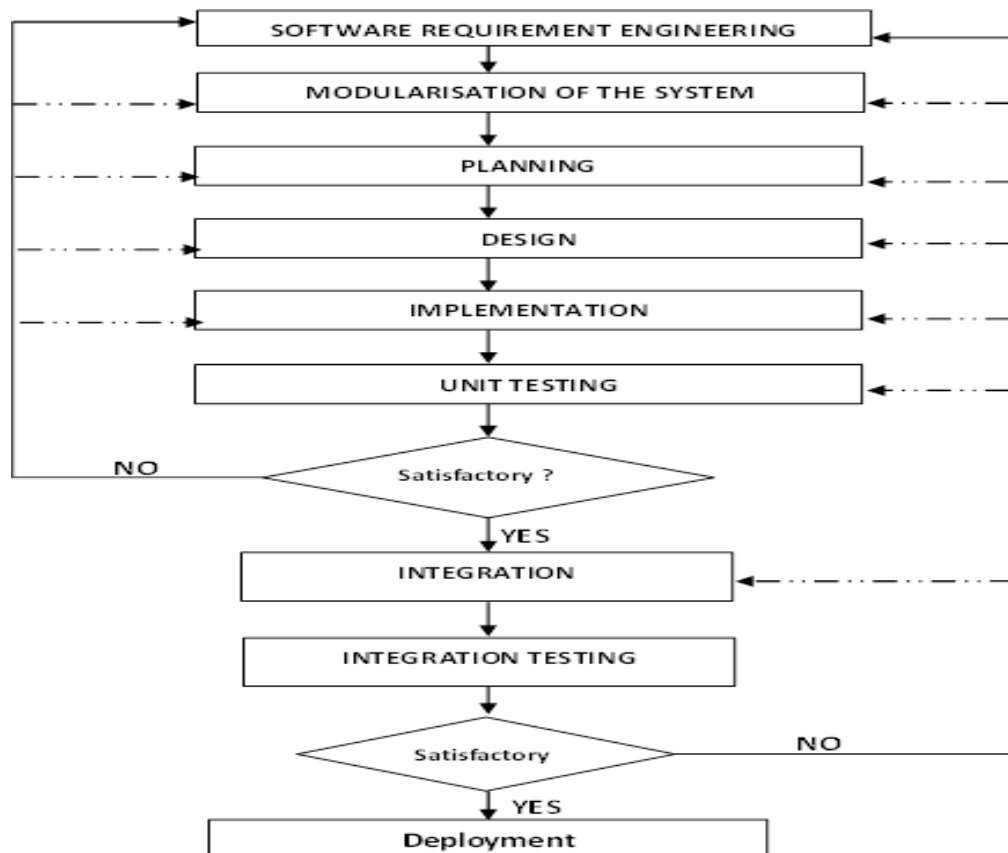

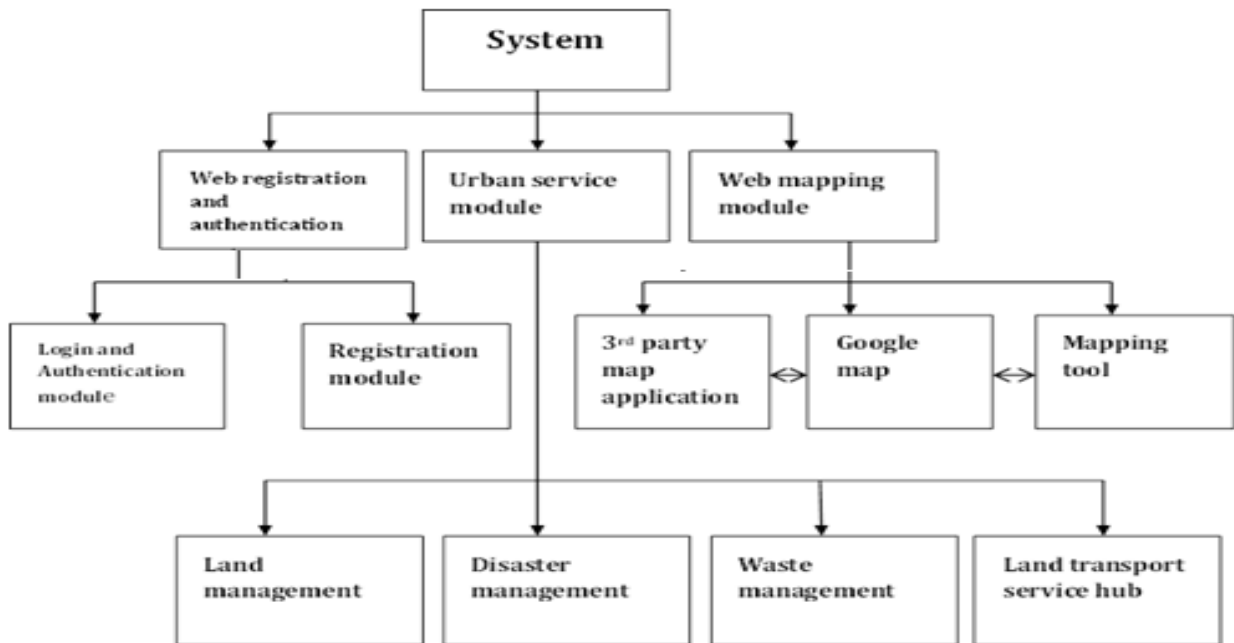**Figure-1.** The Participatory Evolutionary Software Development Methodology (PESDM

Figure-2. Modularization of the system by functional decomposition technique

Then, the detailed flowcharts and flow diagrams of the various submodules are developed. The flow diagram for the registration and authentication module is shown in Figure 3.
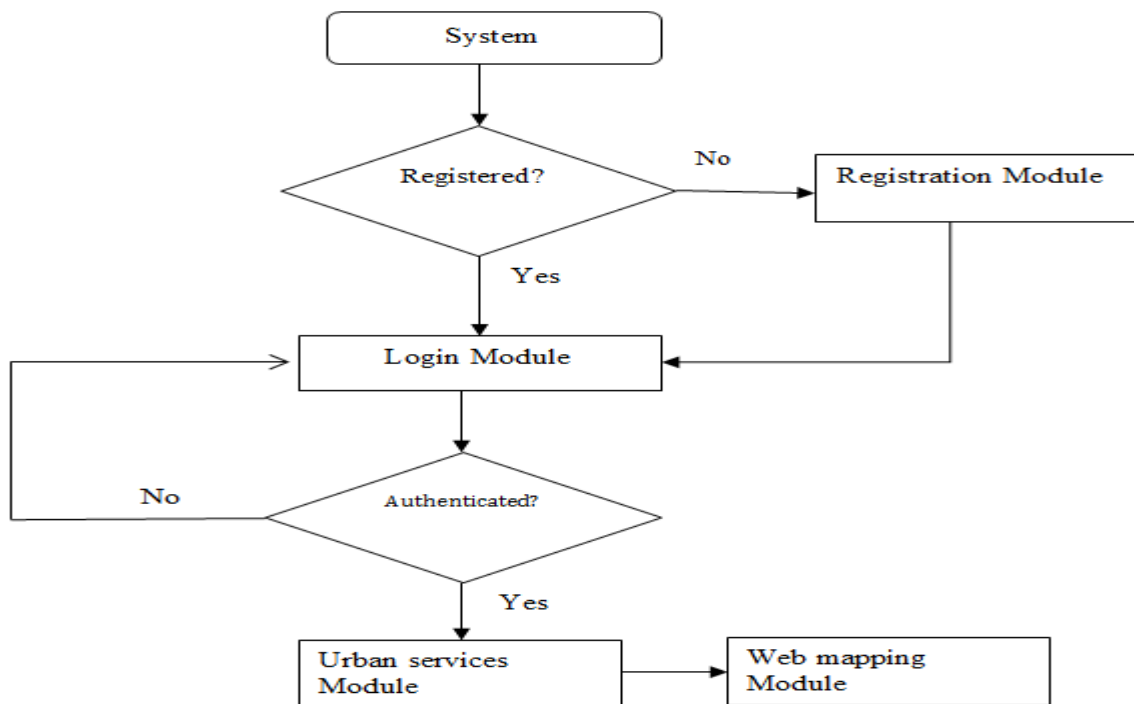

Figure-3. Flow diagram of the registration and authentication module

The land management module: The land management module, as shown in Figure 4 provides the Government housing administration agency with the tools to map and visualize the master plan for a city with detailed information about areas earmarked for different purposes such as market, industries, banking, stadia, parks, etc. It also provides the land registration office the details of properties any area. Furthermore, the public can also lay complaints or make inquiries about housing plans through this module. Also, the module provides an avenue for people to apply for approval of housing plans which are viewed and given due consideration by the agency concern.

The urban waste management module: The urban waste management module enables waste bins and dumping sites to be mapped, monitored and managed. The stakeholders for this module include the public, environmental agencies and contractors who are hired for waste disposal and management. This module enables the public to report about poor waste management in their localities as well as insufficient refuse bins. On the other hand, environmental agencies can use to map visualize dumping sites and dumpsters for different locations thereby keeping track of how well the contractors are doing their jobs.
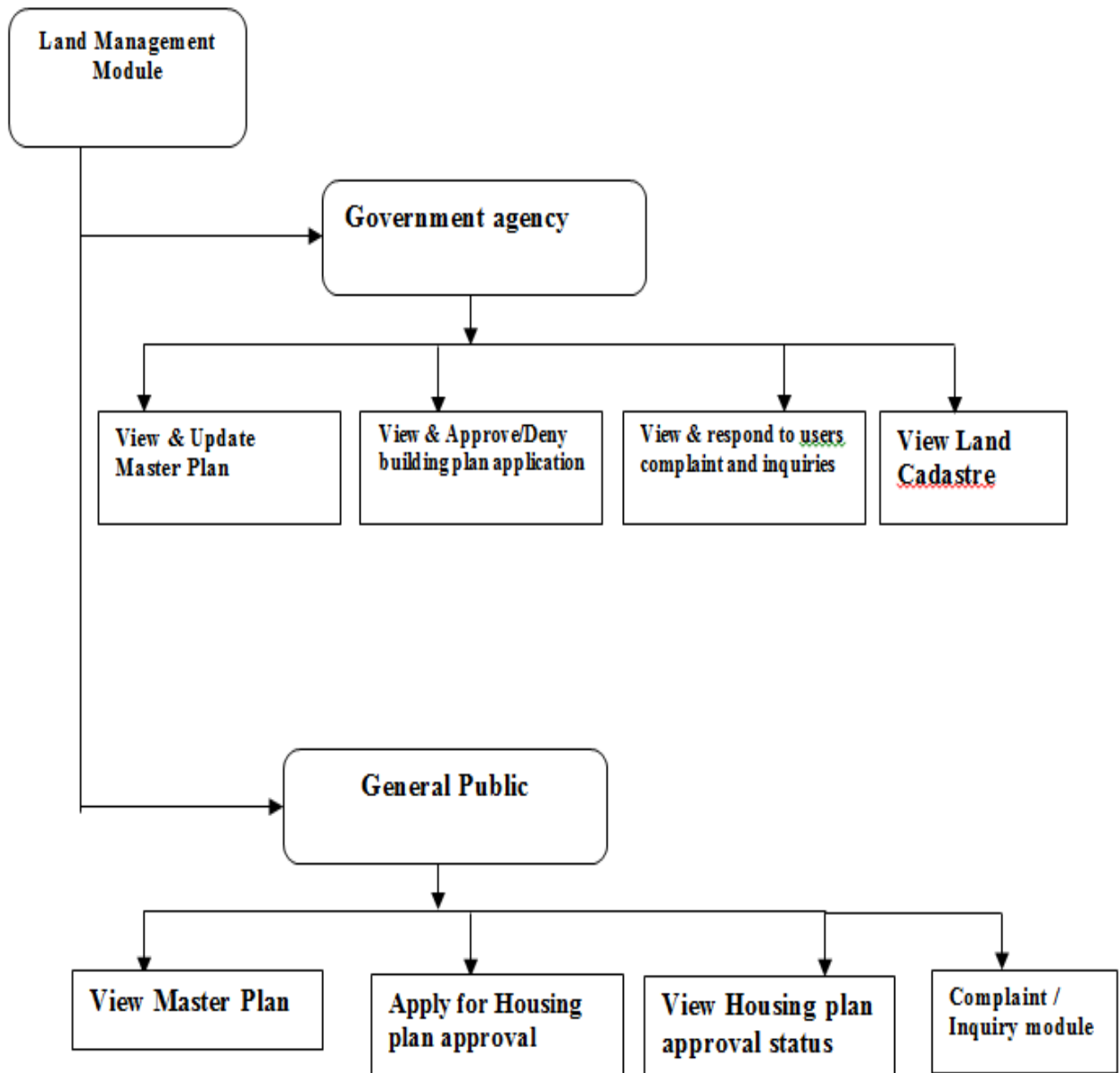

Figure-4. Urban Land Management Module

Moreover, the information gotten by the agency via this platform will also guide them to decide how many dumpsters that should be made available in a particular location and also advise the contractors on the optimal periodicity for emptying each dumpster. The functional block diagram of this module is provided in Figure 5.
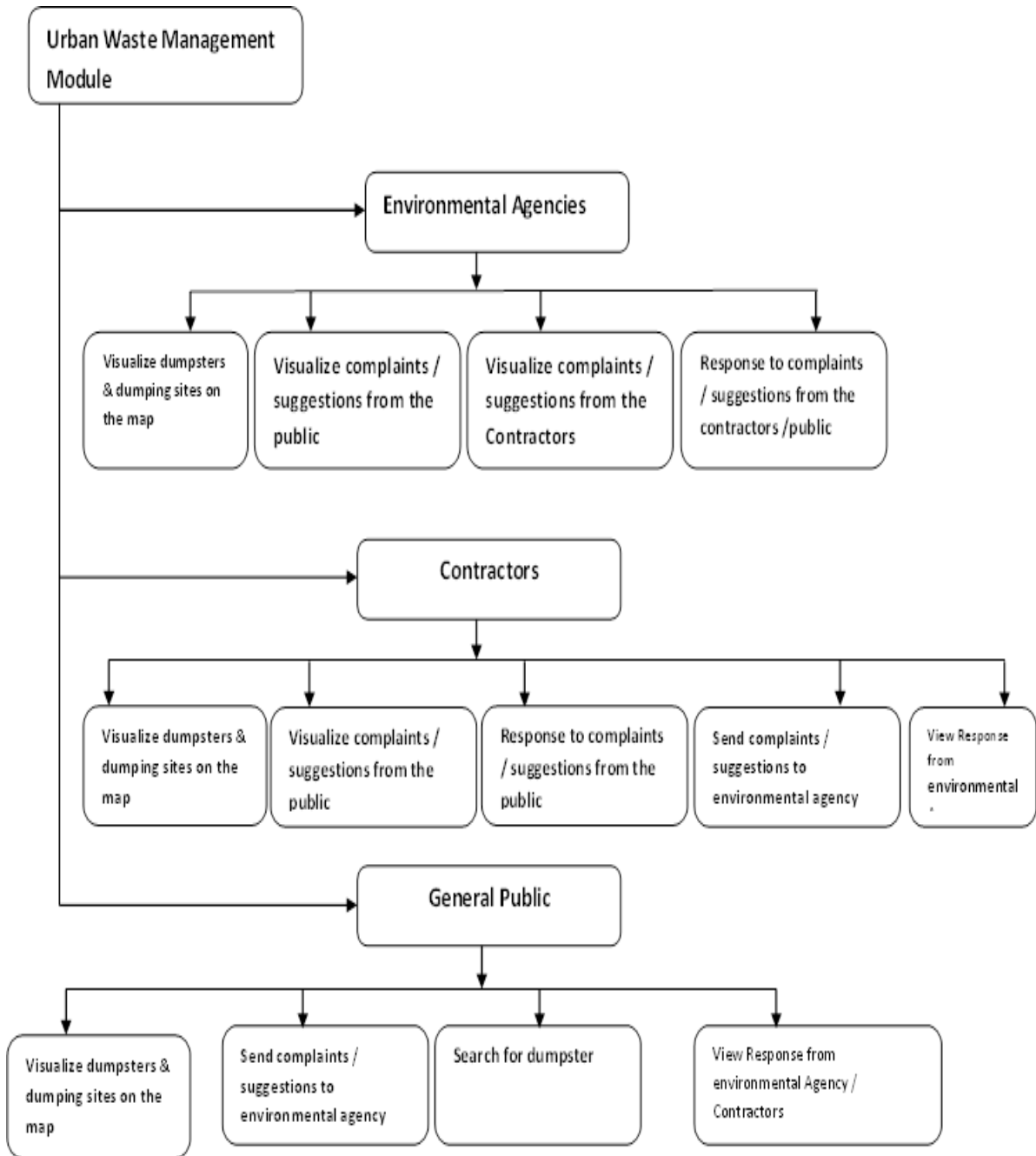
Figure-5. Waste Management Module

The urban land transport management module: The urban land transport management module   serves as a land transport hub where all the services and facilities that are associated with the land transport are made available and accessible to all the system stakeholders through the use of mapping tools. The functional breakdown for this module is presented in Figure 6. The   services in the urban land transport management module include filling stations, car spare parts shops, car hiring centers, mechanic shops, etc. and facilities include parks, roundabouts, flyovers, traffic lights, drivable roads.
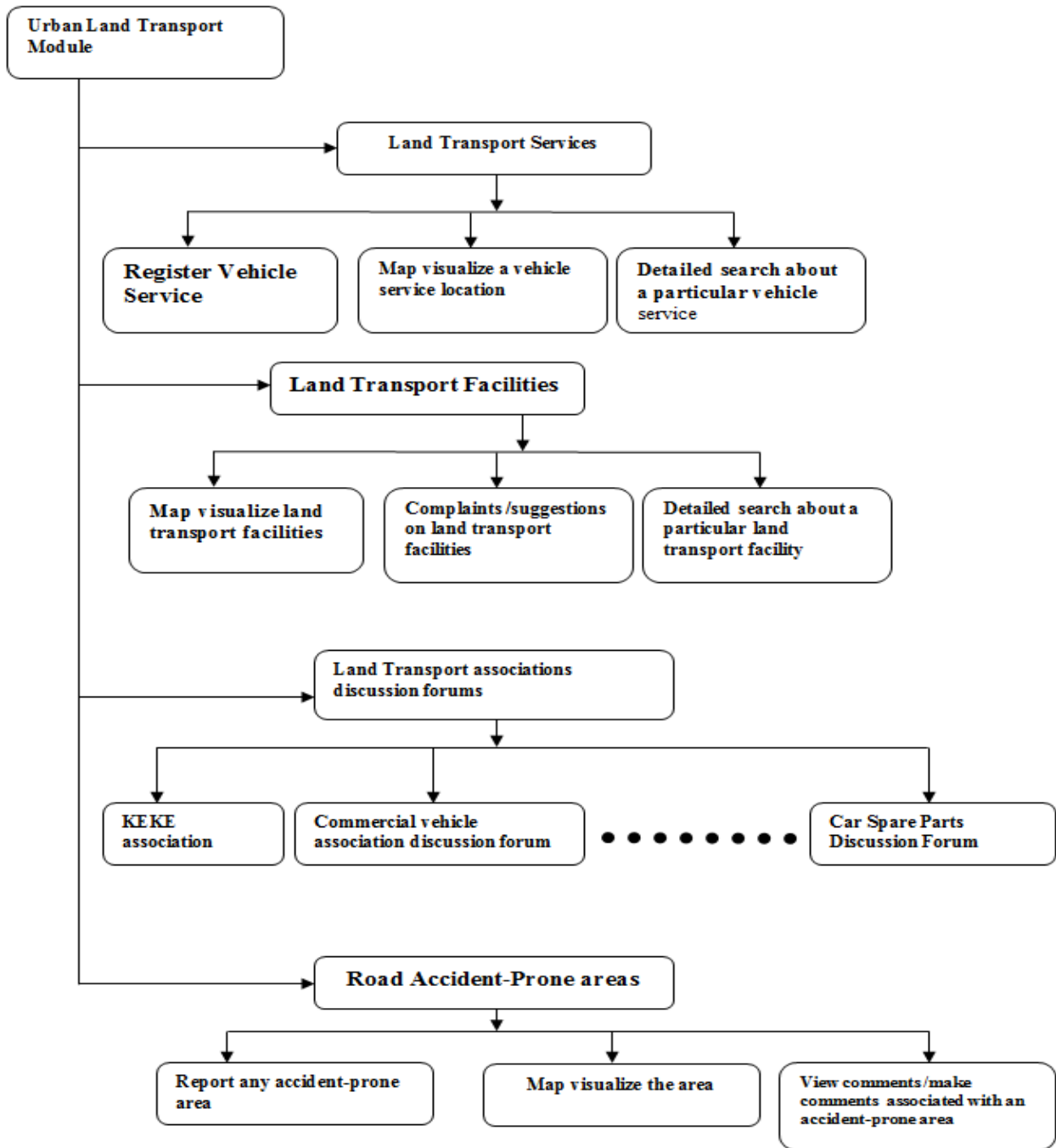
Figure-6. The Land Transport Management Module

Furthermore, the land transport management module (Figure 6) also presents map-based visualization of transportation routes for different means of land transportation. Through this functionality, drivers will be able to access information about accident-prone areas such as places with flood, port-holes, erosion, roadblocks or where accident had occurred and it is currently causing hazard to other road users. To ensure that the information on the platform is up-to-date, the module provides avenue for the system users to provide recent information about the land transport in the city. The stakeholders for the urban land transport management module include the general public, the government agencies responsible for land transportation such as Federal Road Safety Commission and land transportation service providers such as commercial car drivers, tricycle operators, mechanics shops, vehicle spare parts dealers, vehicle rental service centers etc.

The urban disaster management module : The urban disaster management module provides the relevant tools and technologies for mapping and map-based visualization of disaster-prone areas. It as well provides a social

communication hub where the residents of a community can interact with the relevant bodies in case of any disaster or emergency occurrence. The functional breakdown for this module is presented in Figure 7. The stakeholders for this module include the general public whose major role is to make sure that information regarding any form of disaster in their localities gets to the appropriate quarters promptly. To make this possible the system uses both synchronous and asynchronous communication mechanisms such as Google Mashup Apps, discussion forums, hotlines and email addresses. Other stakeholders include the police for terrorist attacks, security tips, safety measures; National Emergency Management Agency (NEMA) for monitoring and management of natural disasters such as erosion, earthquakes, floods, etc. voluntary organizations such as Red Cross and other NGOs who render services to save casualties or victims of disasters; Fire Service Agency for fire incidents.
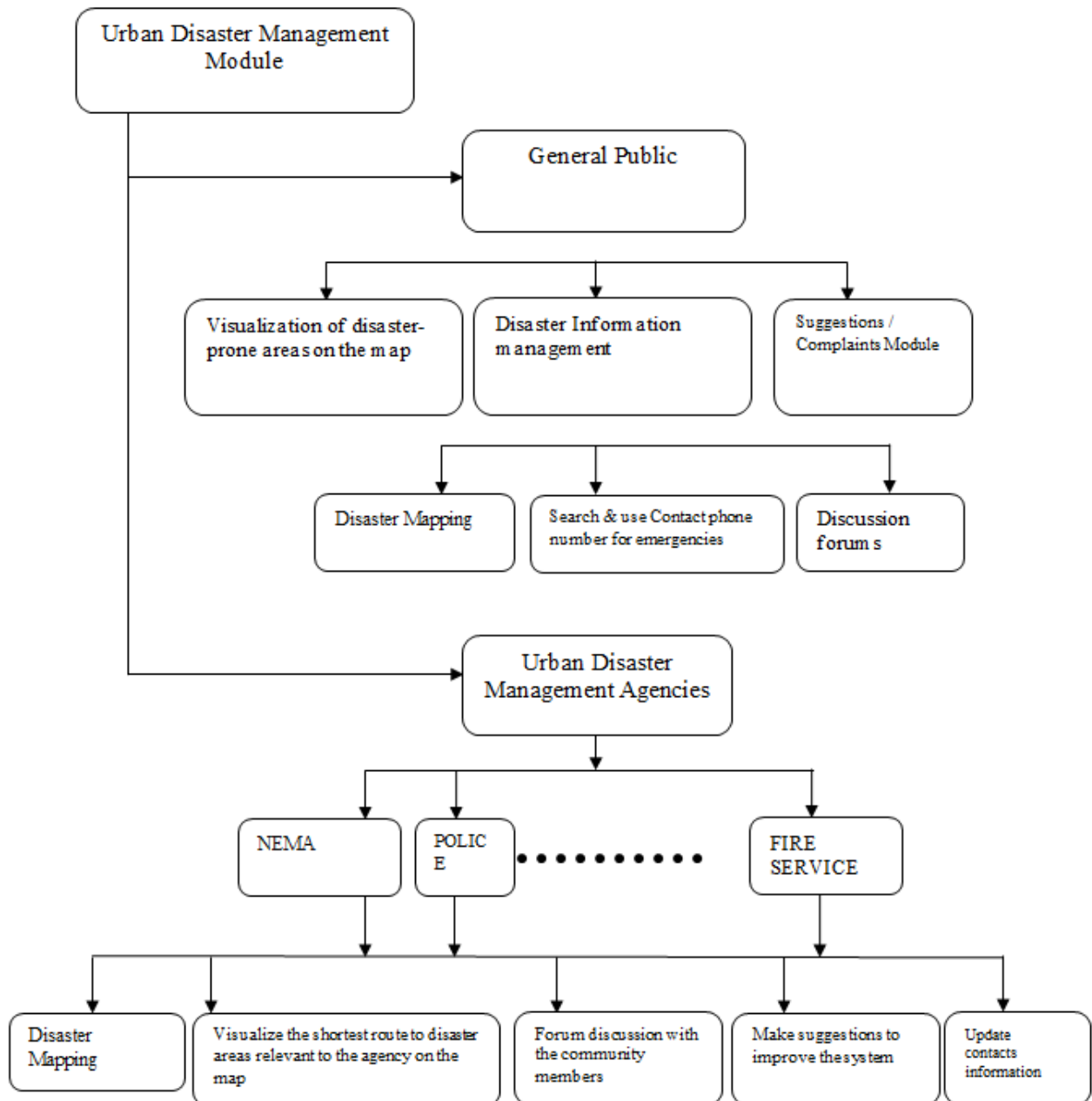
Figure-7. Urban Disaster Management Module

Furthermore, with the mapping tools, the stakeholders can visualize the shortest route to the disaster area thereby providing a prompter response.

The system usecase diagram : The system usecase diagram is given in Figure 8. In the usecase diagram of Figure 8 , the actors include community members, facilitator, Government agencies and partners.
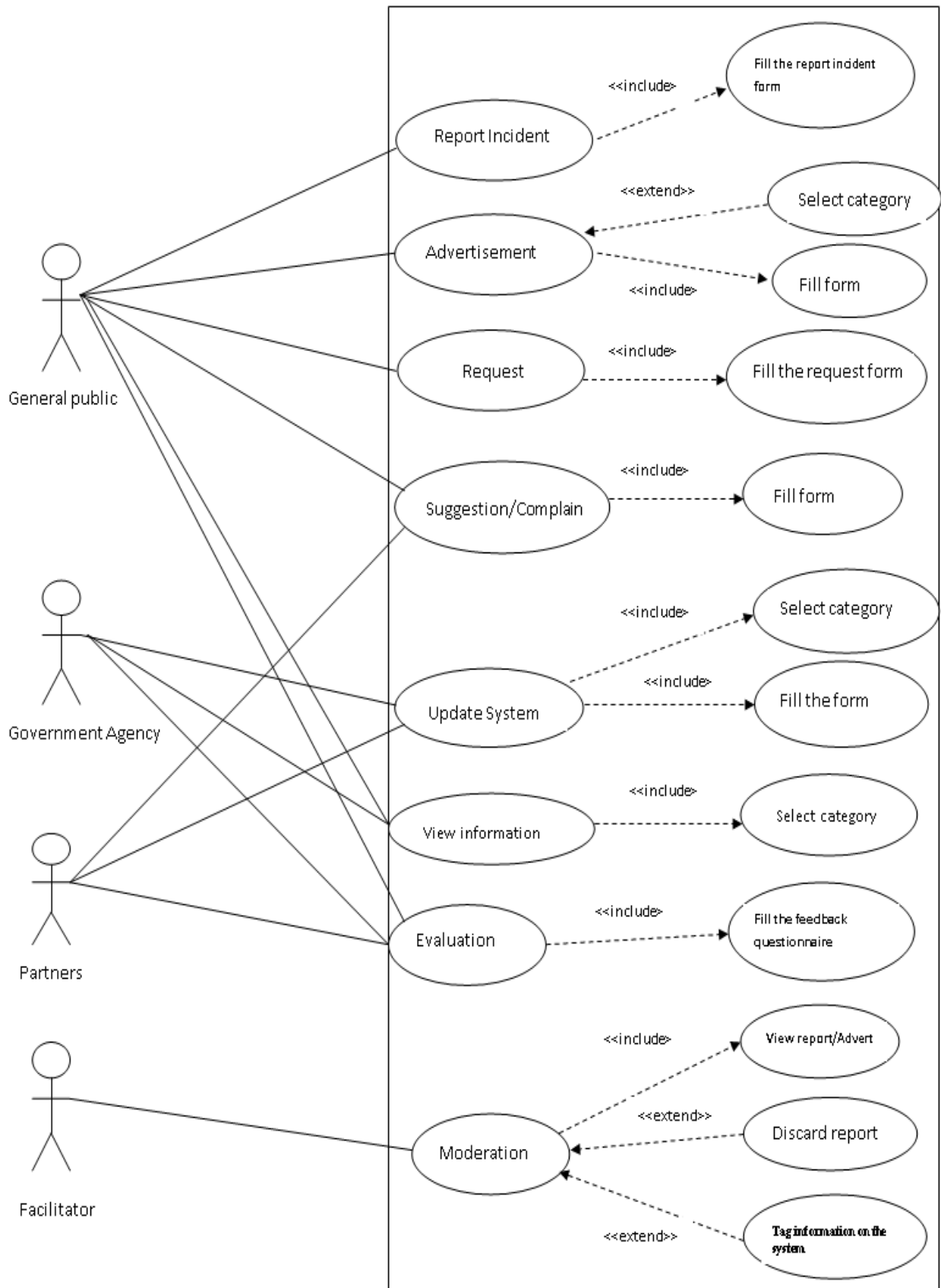

Figure-8. Use Case Diagram for the system

2.1. Flowchart for Selected Submodules

In this section the flowcharts showing the process flow when the user interacts with the system is shown for some selected submodules.
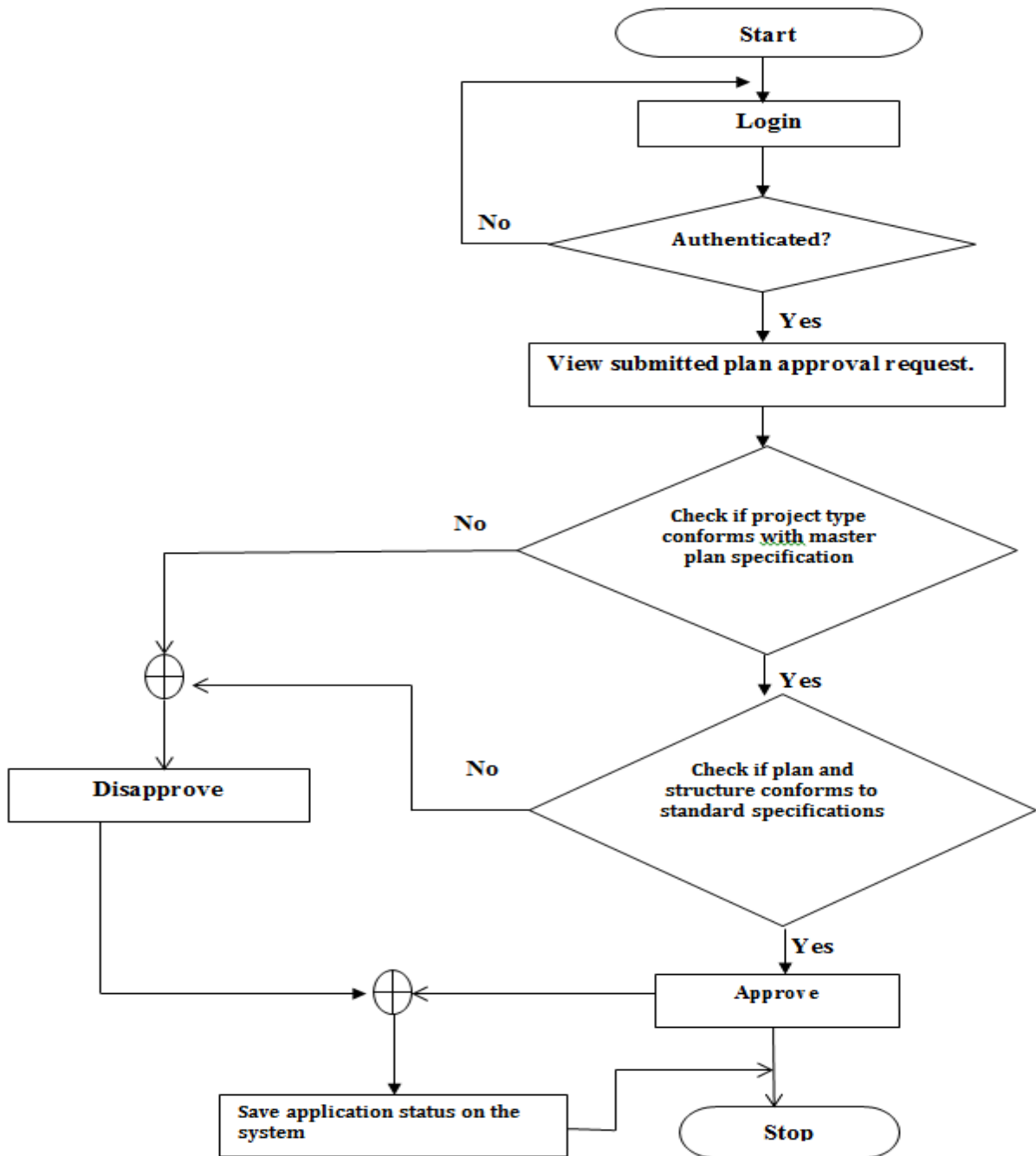

Figure-9. Flowchart for land or house plan approval/disapproval.

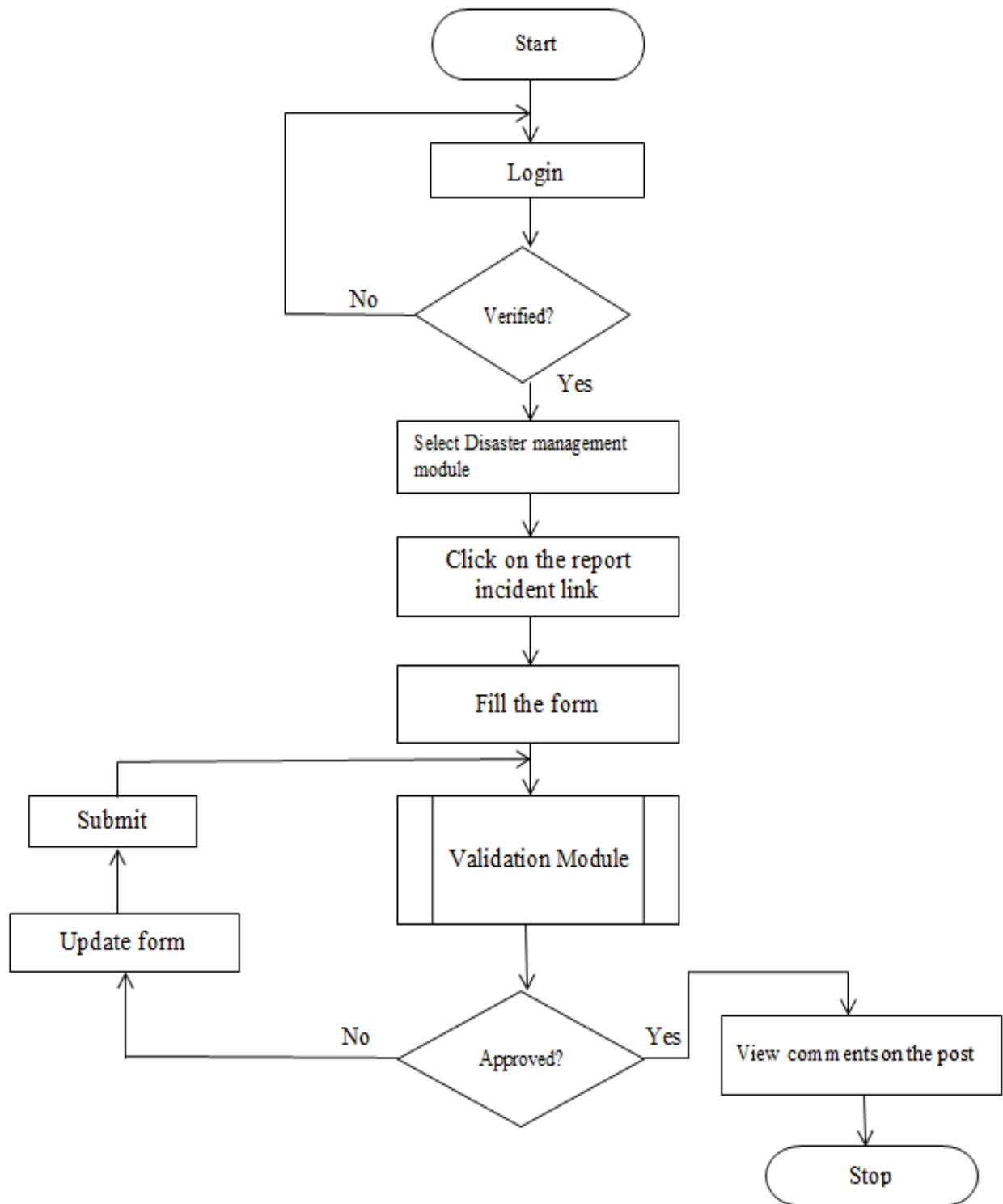The flowchart in Figure 10 shows incident reporting in Disaster Management module

Figure-10. The flowchart for Incident reporting in Disaster Management module

The flowchart in Figure 10 and Figure 11 shows the flow process in reporting an incident or disaster event, and how the moderator validates reported incident before deploying staff and equipment to the site. Validation of disaster incidence report is necessary to avoid responding to false alarms or frivolous on incidences. The validation process requires opinion or response from other people in the reported region.
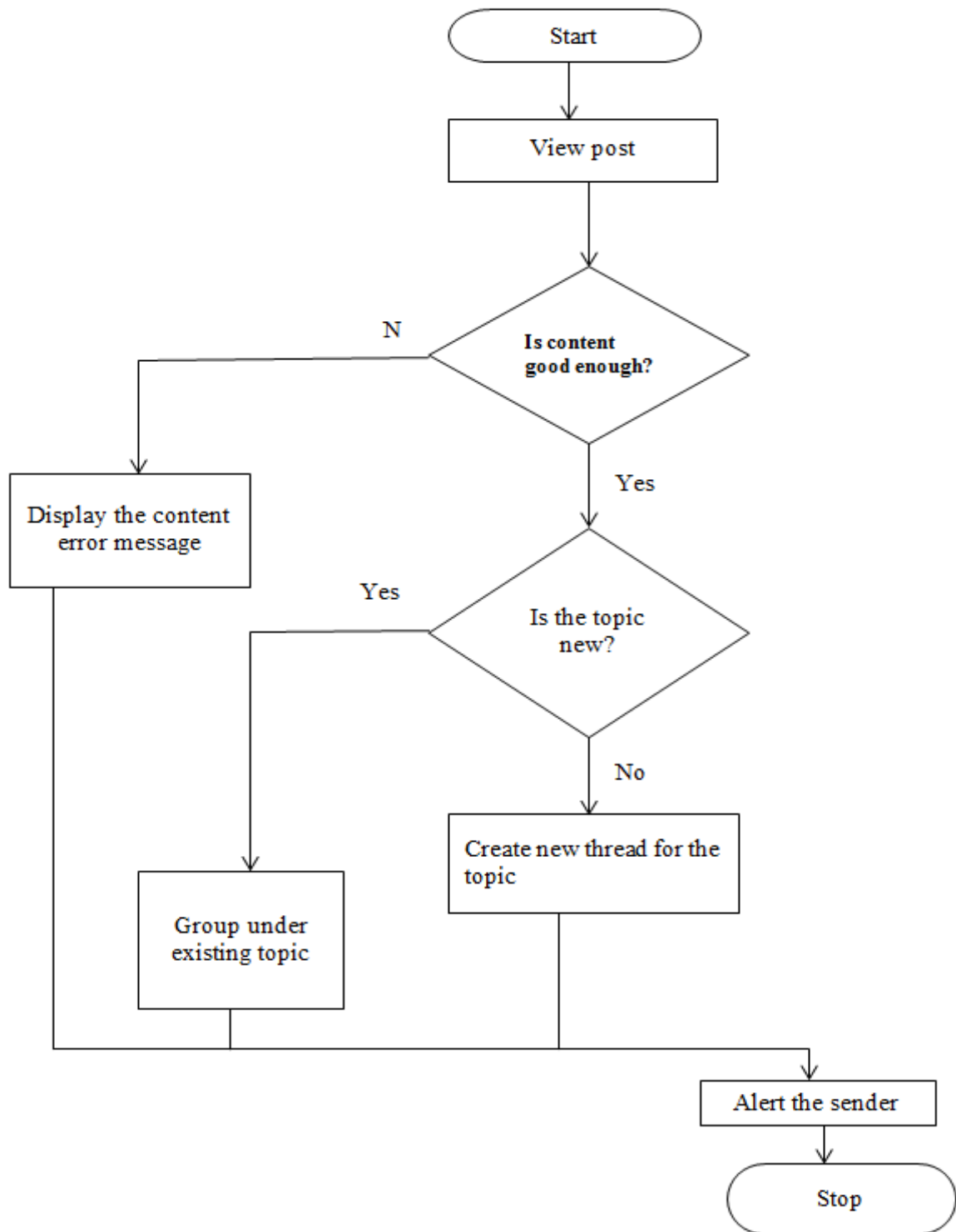
Figure-11. Validation Module

The flowchart in Figure 12 shows the process entailed in registering for alert by a user. A user can register to be alerted for a specific type of disaster situation and can also choose to be alerted either through SMS or Email.
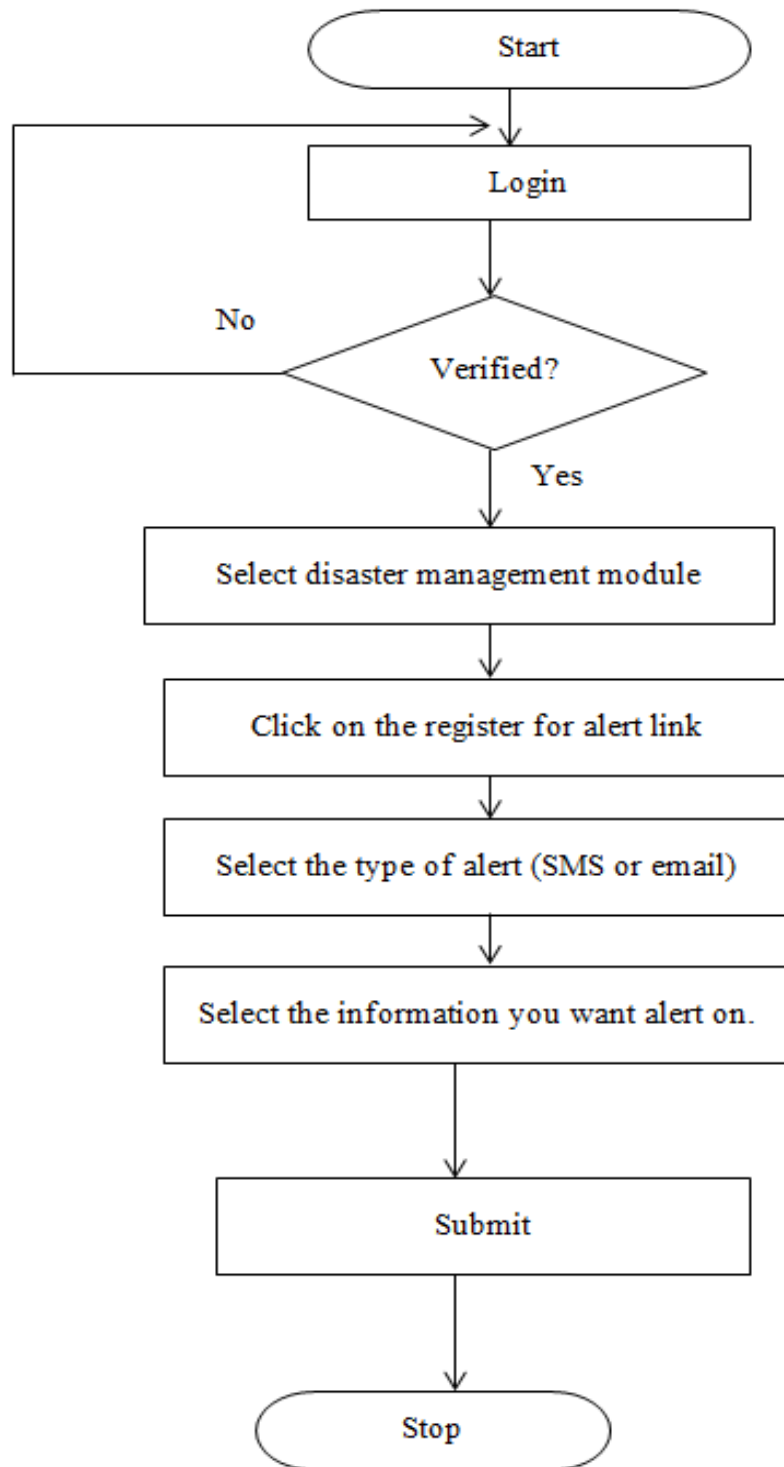
Figure-12. Flowchart for alert registration by users.

3. THE RESULTS AND DISCUSSIONS

At the end of the coding and testing, the web-based SIS was hosted locally on a laptop for offline demonstration. Some sample screenshots that capture various features of the web-based spatial information system are presented.

The screenshot in Figure 13 shows the homepage as well as the links to the four modules, sidebars and the user registration/authentication module
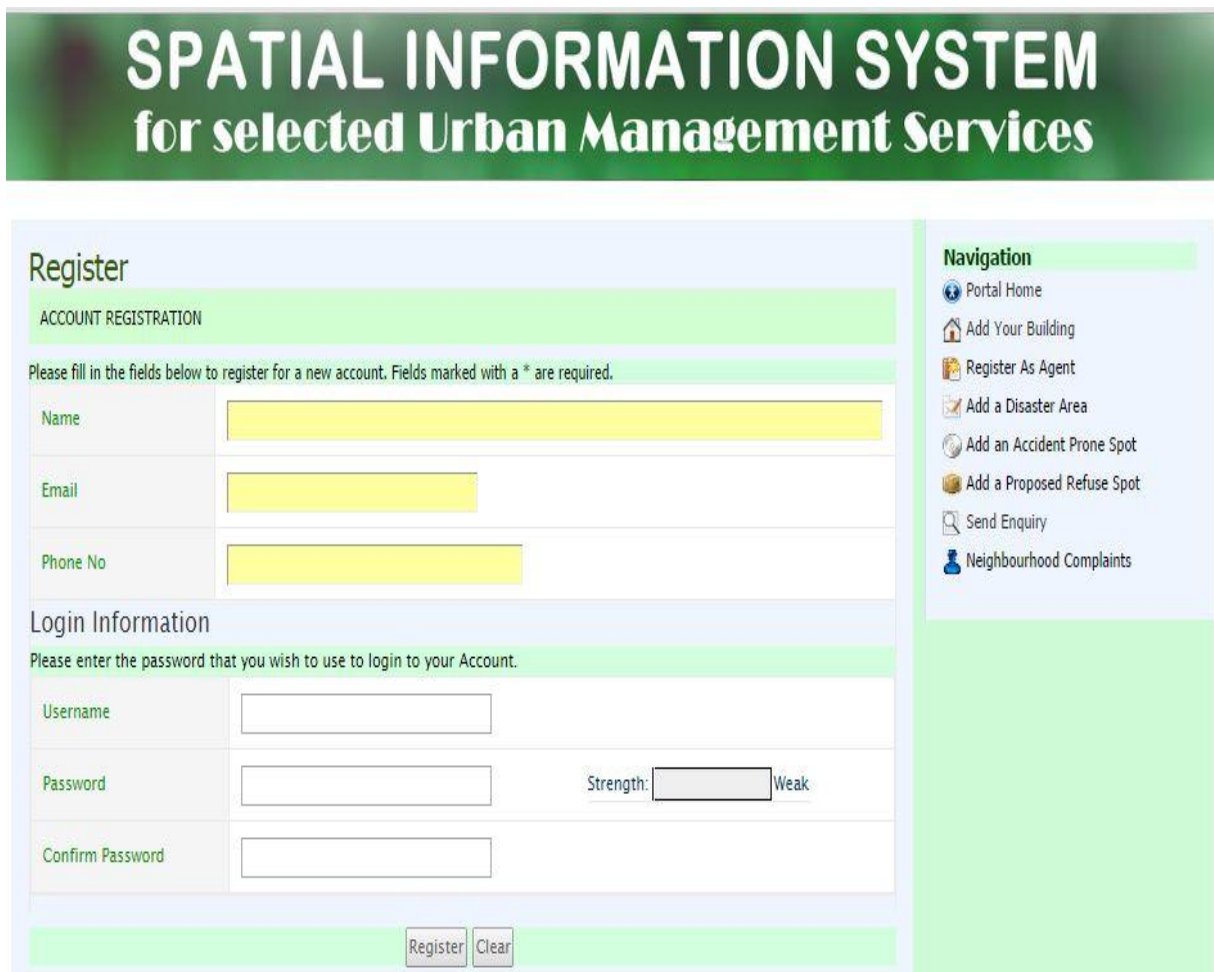
Figure-13. Screenshot of the home page.

Figure-14. Registration page.

The screenshot in Figure 14 shows the user registration form while screenshot in Figure 15 is for application for land or house plan approval. The screenshot in Figure 16 shows approved buildings in an area, for an agent that wants to verify the status of a building or a user that want to verify for the purpose of conveyance.

Figure-15. Screenshot for application for land or house plan approval

Figure-16. Screenshot of Approved buildings in an area.

The screenshot in Figure 17 shows mapping of dumpster in an area from the user's page, for a user searching. The user can also apply for dumpster in his/her area or lay complain form the same page
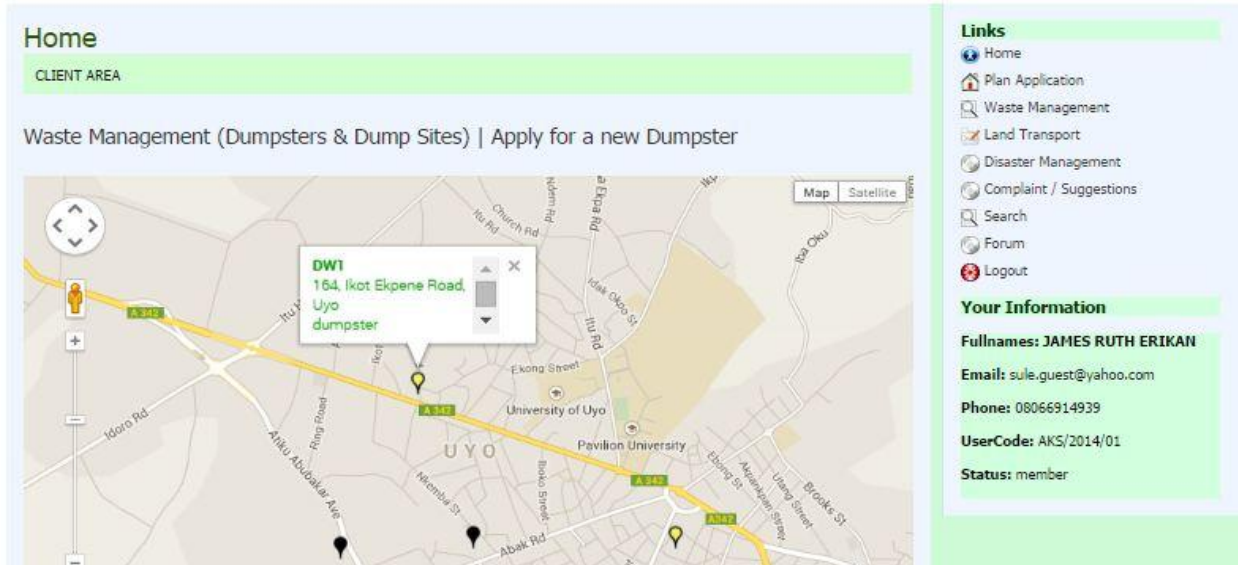
Figure-17. Screenshot showing dumpster in an area.

The screenshot in Figure 18 shows web page for dumpster application by the user. The screenshot in Figure 19 shows mapping of the land transport facilities in an area while that in Figure 20 shows an area with disaster occurrence.
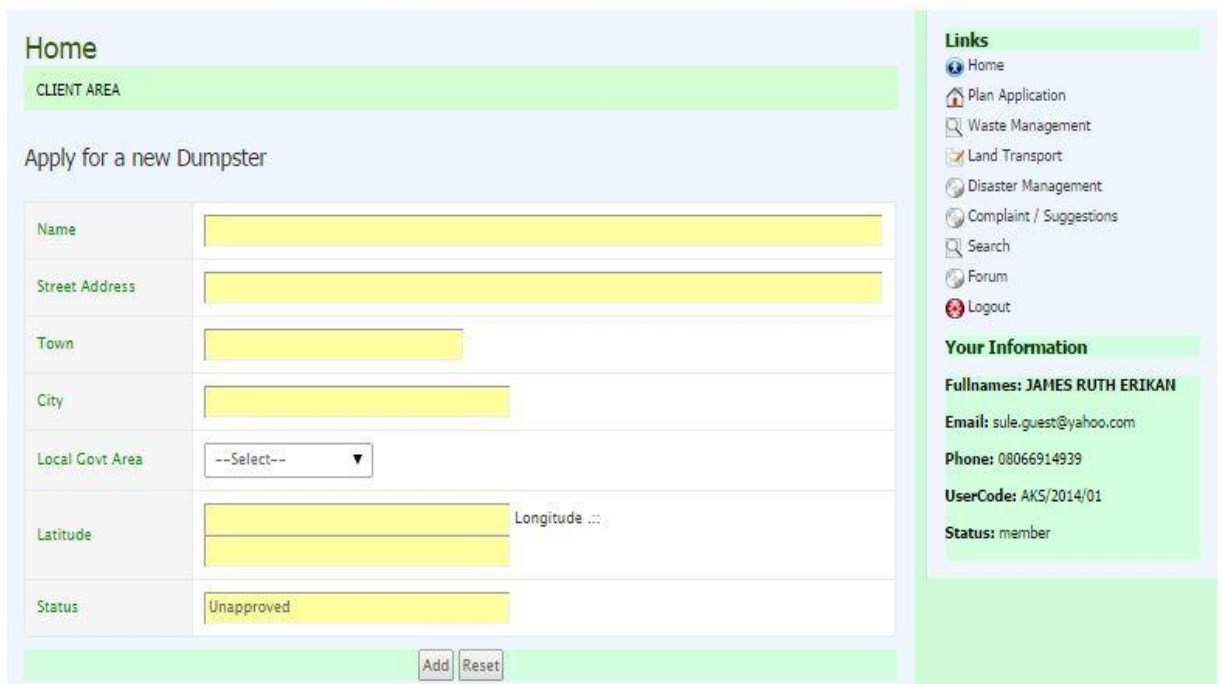

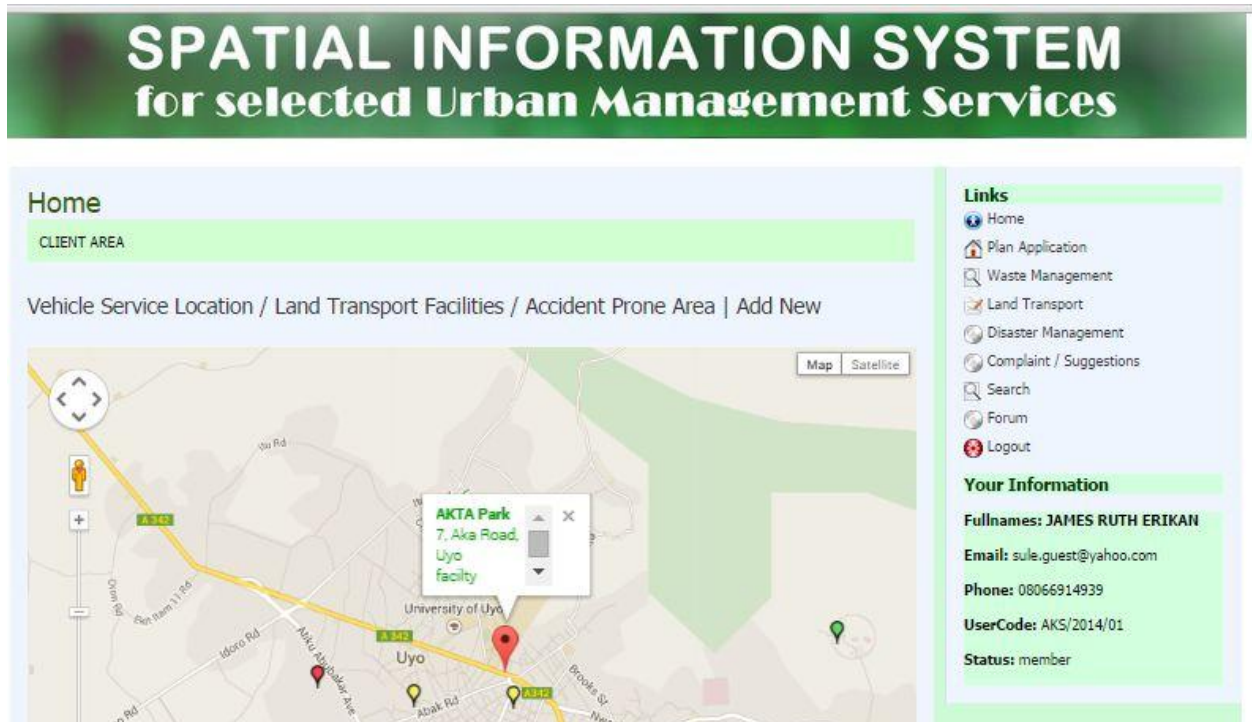**Figure-18.** Screenshot for dumpster application by the user.

Figure-19. Screenshot showing the land transport facilities in an area.
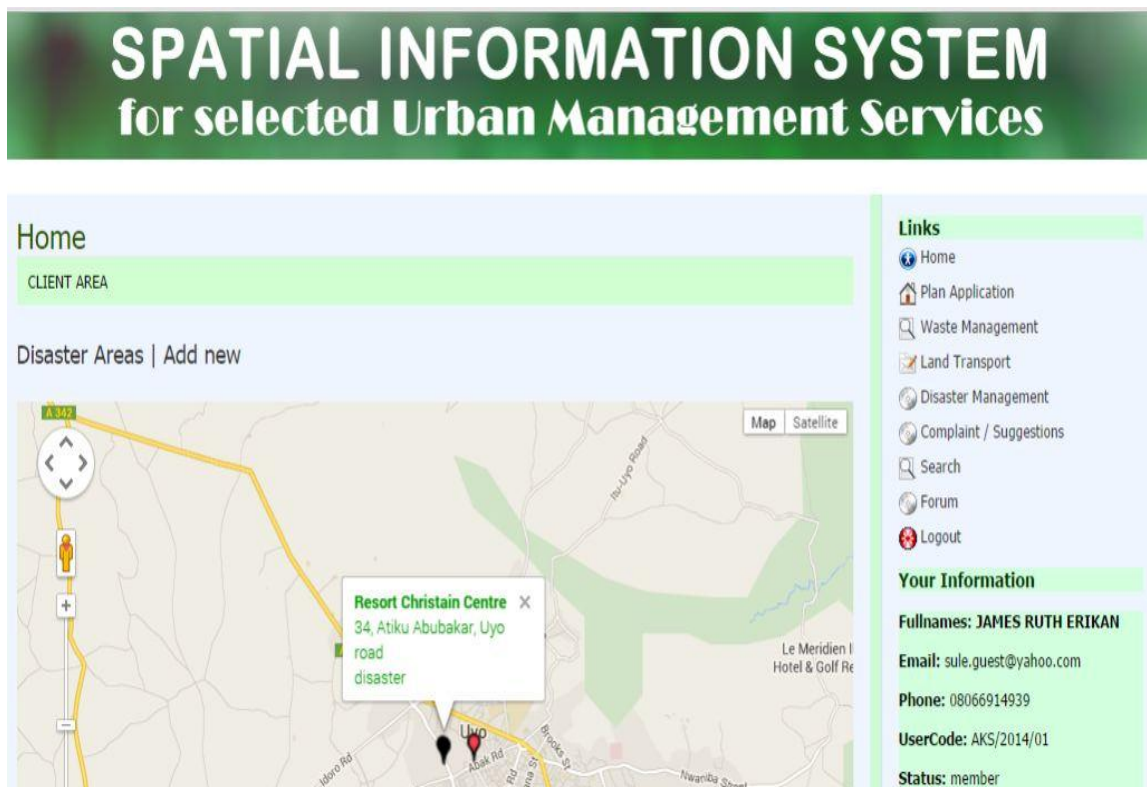

Figure-20. Screenshot showing area of disaster occurrence.

4. CONCLUSION

A web-based spatial information system was developed to provide timely information on urban management service in Akwa Ibom state. The urban management services included in the design are disaster management, waste management, land administration and land transportation information hub. The web-based spatial information system can be accessed, viewed and analyzed by both government agencies, public users and other stakeholders that either use or provide services. Furthermore, a third party mapping application was developed using Google map

Application Program Interface (API) version 3 to enable the mapping of urban services such as master plan of the city, services and facilities in the city and also disaster-prone areas or areas of disaster occurrence. Other mapping tools such as the geocoding tool were also implemented in the system to facilitate the collection and processing of spatial information. Search tool was also implemented in the system for locating specific services and facilities in the community. The web application was hosted locally using WAMP server and tested with some dataset obtained in the case study area.

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