Masters Program in Geospatial Technologies

PUBLIC PARTICIPATION GEOGRAPHIC INFORMATION SYSTEMS IN DEVELOPING COUNTRIES.

Lessons from Uganda on the impacts of interactive screens in PPGIS and community perceptions of space.

Pamella Drate

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ABSTRACT

Town planning is highly a community initiative, if community efforts are sought-after in the most convenient approach, sustainable plans are produced. In this study, an interactive screen, pen and web 2.0 are used in an urban planning exercise to enhance public participation in Uganda. PPGIS applications are increasingly used in disciplines related to Geographic Information science in most parts of the world. However, developing countries with low technological advancements, experience only a glimpse of the GIS benefits.

The study is based on a combination of traditional methods and a web 2.0, this is inspired by studies done by Al-kodmany 2001. The web application is developed from open source software, firstly because the software is readily availability, secondly to create a simple interface that is more user friendly and meets the aim of improving participation levels. The method follows a traditional community meeting, where participants gather to make comments about a neighbourhood plan produced by Bugembe Town council. The plan from the web application, is projected on to a wall which is made sensitive to an interactive pen. The community maps their comments directly on the projection using the interactive pen. The comments are stored in a GIS database for the planner to retrieve and incorporate in the final plan. The usability assessments are done using questionnaires, recordings and physical checks. This is followed by engaging the communities in mapping landmarks in their areas, purposely, to understand their perceptions of space and representation of spatial features.

The results are overwhelming as the communities easily map their boundaries on the web application using the interactive screen; the application was tested by people from all walks of life. 74 percent of the participants appreciated the application and found it easy to use.

With the recommendations and wealth of information provided by the communities, the application will fetch enormous results in the field of public participation in Uganda, at the same time making the town planners work easier, improving accuracy levels of data capture and ease in data sharing.

KEY WORDS

Boundary

Community

Empowerment

Geographic Information systems

Land uses

Public Participation Geographic Information Systems

Public Participation

Stakeholder

spatial

Technology

Urban Planning

Web 2.0

ACRONYMS

API- Application Programming Interface

3D – Three dimension

GI- Geographic Information

GIS- Geographic Information Systems

GIS- Geographic Information Science

GPS – Global Positioning System

GT- Geo-spatial Technologies

HTTP- Hyper Text Transfer Protocol

IAP2 – International association of public participation

NCGIA – National Centre for Geographic Information and Analysis

PPGIS – Public Participation Geographic Information Systems

SRID – Spatial Reference Identifier

UBOS – Uganda Bureau of Statistics

WFS -Web Feature Services

WFS T -Web Feature Services Transaction

WMS -Web Map Services

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1. INTRODUCTION

1.1 PUBLIC PARTICIPATION AND URBAN PLANNING

Public participation in the field of urban planning is a difficult venture in many communities; the lack of motivation remains unknown. To determine why, this study will be conducted using a web 2.0 application and an interactive screen in a developing country.

The notion that public participation carries varies from one field of application to another. In urban planning, community effort is greatly desired in the preparation of development plans. This is done to ensure plans are based on local decisions to solve local problems, thus a bottom up approach.

Communities are more informed of their surroundings; problems that affect their day to day activities, they have a better understanding of what the future should be. The best plans are therefore those that are community driven. The community has to be persuaded to participate otherwise the plans are alien to them making implementation impractical.

Public participation approaches have been influenced by Arnstein's participation ladder(Arnstein 1969); which describes the transfer of political power from traditional power holders to citizens, to enable communities achieve their own requirements.

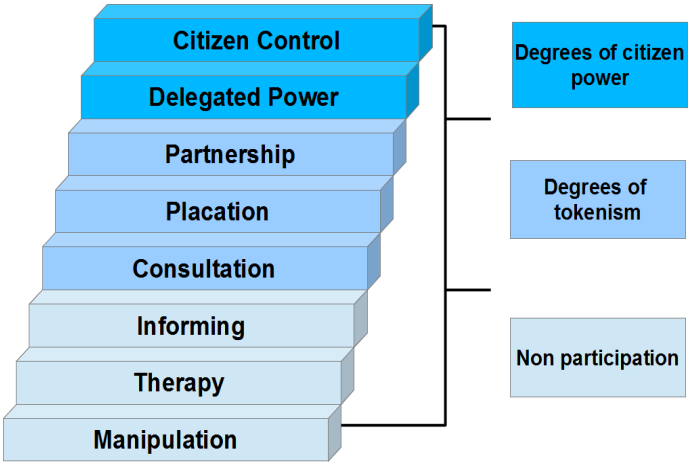

Figure 1: Arnstein's Participation ladder (source: Arnstein 1969)

In figure 1 above, she characterizes eight participation components into three major themes of; non participation, which is at the bottom level of the ladder, implying the community is only educated and told what will be done; the tokenism which is the central theme, involves community giving advice and being heard; the top most ladders represent the citizen power theme, here, the communities create partnerships, delegate power and are in control.

Arnstein's participation ladder has inspired many approaches that involve community input, PPGIS studies are highly influenced by this ladder for citizen engagement and marginalisation.

The term: "public participation geographic information systems" (PPGIS) was established in 1996 at the meeting of the National Center for Geographic Information and Analysis (NCGIA). The meeting's emphasis was on *GIS and Society: the social implications of how people, space, and environment are represented in GIS.* (Craig *et al* 1998).

PPGIS approaches aim at reducing the community nonconformity with GIS, basing practices on a bottom- up GIS, where the communities are the sole drivers of data provision, use, sharing and manipulation. The focus is on the non experts and occasional GIS users. (Hacklay and Tobón 2002)

PPGIS approaches are on the increase in many applications and more so in the developed countries. Approaches are changed from time to time basing on the community experiences, resources, time frames and levels of concern in the decision to be made[1].

Although there is high advancement in PPGIS approaches in the western world, mainly technology based, public participation methods should be based on community experiences than technology. PPGIS involves understanding the kind of community in terms of their cultural and social aspects, analysing approaches used in the past, measuring, assessing their performance and then identifying better methods.

Web GIS is the recently used PPGIS approach, which has given capacity to traditional GIS methods. The invention of Web 2.0 has contributed greatly in the discipline of PPGIS. A Web 2.0, which is computer and internet based, allows its users to interact with other users or to change website content to their requirements. The web pages are more dynamic, creating a rich exposure for data generation, manipulation and sharing, activities which in the past were for the GIS experts only. Web 2.0 applications for PPGIS have produced very promising results since the communities participate at their convenience. (Batty *et al* 2010**,** Goodchild 2007).

Technological advancement in developing countries is still at the early stages; as a result, many countries still use traditional GIS methods which yield immense results and suit the purpose. However some of these methods create wide gaps especially in terms of getting and using feedback from communities, the planner undergoes double efforts in capturing community comments into the GIS data base and creating mistrust among communities as to whether their comments were considered since these are written down on paper.

As a result, these approaches have cost the participation processes, as well as discouraging the community from making changes that would impact on their lives. A gradual change from old participation methods is necessary since we learn from experience and adjust accordingly.

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1 International Association of Public Participation(IAP2)- http://www.iap2.org/: provides guidelines and training for enhancing public participation in different parts of the world. The participation spectrum is highly used in different stages of public participation

A combination of the low technology and high technology would yield good results. The high technology would be used for building the interface while presenting a simple interface to the users.(Al-kodmany 2001)

Geographical scale in PPGIS has huge impacts on the participation levels. The size of the community has an influence on the method to use and therefore its performance. Participation is more promising when a small representative community is used. At national levels, the percentage of the population interested to participate is likely to lower than when the participation is centred at the local level. The scale of the community therefore should dictate on which method or approach to use in the participation process.(Kingston and smith 2007).

Besides using the web 2.0 application and the interactive screen, the study will involve understanding the community perceptions of space for enhancing public participation. This is inspired by, Carver 2001, in his studies about Participation and GIS, he suggests that studies on community perceptions of space, would address some of the weaknesses in participation and GIS. Community perceptions of space are increasingly being studied in not only planning fields but in areas where the community understanding of objects, features is required. Different professionals have different ways of representing spatial features, a road, for example, means differently to a town planner, cad-astral engineer, road engineer, and surveyor. For some, a road is just the carriage way, while for others it includes the utilities lines, drainage channels, the pedestrian precinct and the cycle lane. This therefore influences the way the road is represented on maps and presented to communities. Perhaps communities may have a different understanding of space than what is represented to them; participation therefore becomes compromised with little understanding of what is presented.

1.2 Background

In Uganda, town planning is one of the highly recognized disciplines involving public participation. Planning procedures are legislated[2], requiring public involvement at all stages of the process to ensure that the locals are empowered and in charge of causing changes in their own communities.

The planning process follows a number of sequential steps, of which 80% is community driven. The planning starts with problem identification, the community concerns are sought and priority areas identified.

The subsequent stages involve plan preparation, where the planners give technical guidance to solve the problem/s. In the final stages, the prepared plan is presented to the communities to which they can still make changes and these are incorporated in the final plan. The plans by law,

2 Physical planning Act 2010: The planning processes are documented in the act which are also in line with the constitution used in the country. This makes planning a legal process, once the plans are approved by the community, they become legal documents.

are left on deposit for a period of time to enable community members who could not attend the consultative meeting, have an opportunity to contribute.

Initially planners prepared development plans on drawing boards; different map layers were then over laid and traced to generate the final base map on which the planning proposals were drawn. This process involved the use of tracing paper and drawing pens, in case of a mistake, the adjustments were done in rudimentary ways. The system is exposed to more errors since the tracing paper is subject to expansion and contraction depending on the weather conditions.

With the introduction of GIS, some planners have now realized the benefits of using the GIS desktop tools to generate plans, manipulate data, yet others still use the drawing boards..

Figure 2 below shows the planning steps followed, importantly, 80% of the input comes from the community to enable them own the plan.

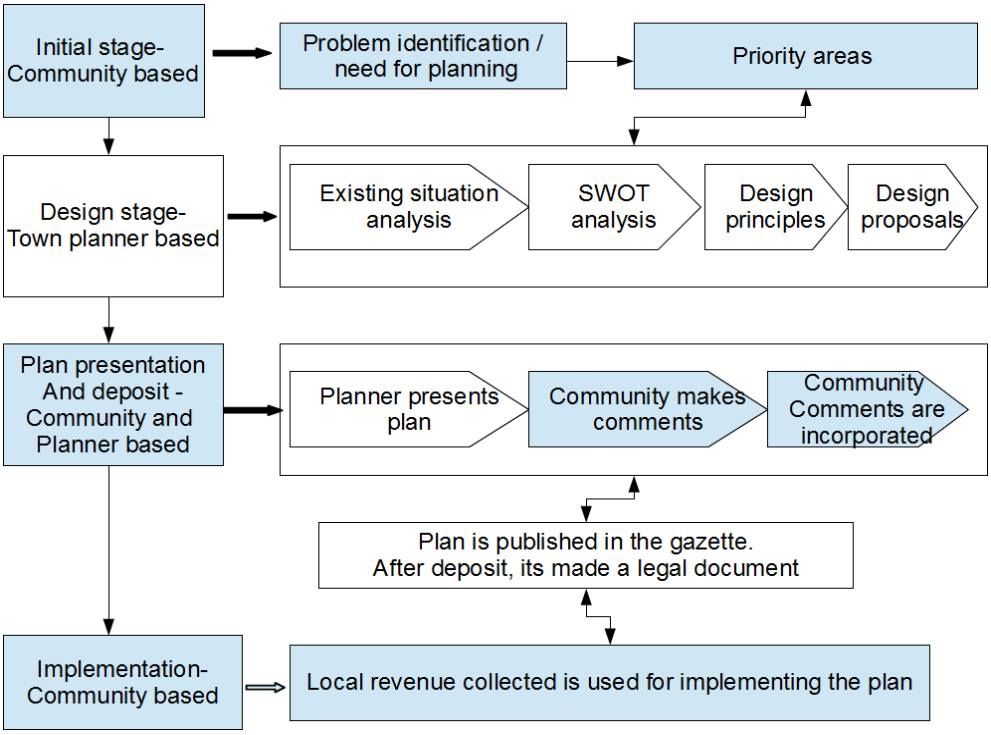

Figure 2: Planning process in Uganda

1.3 Problem Statement and Research Justification

In Uganda, urban planning studies use GIS tools merely for production of plans, data analysis, manipulation and retrieval. There are limited studies on PPGIS in urban planning particularly in Uganda.

The problem in this study is related to the planning process in the country, at the community involvement stages, which could perhaps be the cause for the low participation levels in the planning discipline. In addition, the study will analyse the public perceptions of space and spatial aspects of decision problems. The planning process shortcomings are further explained in the following paragraphs.

In the planning consultative meetings, the traditional methods of pen and paper are still used to capture community comments, these comments are eventually entered into the GIS database upon return to work stations since most of the meetings are held in distant areas from the planners' work place. This poses problems of estimations since the information is taken from paper and pen to the computer. This process is subject to a number of errors and questionable levels of accuracy since the corrections are based on estimates. This consequently leads to double efforts and time, to recapture data that would otherwise be handled at once in the field operations. This traditional method creates doubt among the community, wondering whether their comments have been considered or not. Community members have always been in doubt if their comments are considered and captured the way they expressed them especially with the traditional method of paper and pen. As a result this has affected the confidence levels in community participation. Illiterate locals are always cautious of their decisions, often times doubtful if their ideas are considered relevant, perhaps this is reason for their low participation levels during the planning meetings.

Community members have different ways that are convenient to enhance their participation, some people are very vocal, expressing themselves very freely in public yet they may not have all the necessary information needed in the planning process. However others prefer to participate in a detached environment, to express their views confidently. The traditional meetings have created a rich platform for the most vocal community members and have poorly neglected those who shy in the public and yet have brilliant development ideas.

Incorrect data entries have affected the process of plan implementation, after the plan preparation, surveyors take on the plans to survey the major land uses, boundaries among others. Often the information does not correspond to the ground truth especially in terms of location; making their work impossible and therefore halting the plan implementation process.

Planning data captured on paper and pen, creates difficulties in information sharing with other professionals since the planners have to interpret and understand the community implications yet the information may have urgent needs. This leads to untold delays in the process of data sharing and dissemination. This eventually compromises other development procedures in the related sectors and the country as a whole.

It is against the above problems that this research will be conducted to analyse the causes and establish remedies to combat or reduce the problems faced during the planning process. Perhaps these problems have hampered the plan implementation process in Uganda

1.4 Study Objectives

The general goal of this study is to assess the viability of a web application using interactive screens in public participation in developing communities like Uganda, with low technological levels. Web applications using interactive screens for public participation are very ordinary in developed countries, however in Uganda, this application will be different considering the environment; the study will assess whether the application improves participation among the locals or draws them even further from participation.

The specific objectives in the study address mainly traditional planning related problems expressed above that are experienced in the community participation processes.

The study objectives are divided into three core components, which support the realization of the study goal:

1. **To develop a web 2.0 platform that will create an interactive podium for participation.**

The platform will be built to enhance visualization of the maps, edit and save comments into a database. The prepared plans will be projected from the web application and communities will use an interactive pen to make comments on the projection which will be stored into a GIS database.

This will create an avenue for direct comment capturing, reducing the double efforts in the past associated with data entry at the same time enhancing high levels of data accuracy and ease in data sharing.

2. To test the application in a real world situation.

The application will be tested in Uganda in a real time workshop, to assess its significance in enhancing public participation. This will be done during a traditional community meeting, since few people have internet connection and laptops, therefore they cannot use the application from their homes. The workshop will be centred on a neighbourhood plan prepared by the council, community comments will be sought as provided for in the planning laws and regulations of Uganda.

The workshop proceedings will be used to gauge how the community uses the platform, through physical checks and assess how people interact with the application. This application will provide an opportunity to record directly community comments. Usability assessments will be done to analyse if the web 2.0 platform and interactive screen enhance public participation in Uganda. This will be done using questionnaires, recordings and physical checks to see how people easily interact with the application.

3. To understand the community perceptions of space.

Different professionals represent spatial features differently; the study will analyse the lay people's interpretation and representation of spatial features as they map their opinions onto the interactive screen and paper map. Perhaps the way professionals like planners, surveyors, cad-astral engineers among others represent space is not clearly understood by most local people, this

could be a reason for their low levels of participation in the planning process. The community will be encouraged to map landmarks in their respective areas using paper and pen. The study will analyse the problems, if any, that communities have in understanding the way spatial data is represented.

1.5 Research Questions

The study will analyse the level of influence of a web 2.0 platform using an interactive screen in enhancing participation among the community in the planning process. The opinions of the planners will be sought about this study in relation to how they conduct their duties in the field during the planning process. The following research questions will be considered to address a specific research objective:

Study objectives	***Research Questions***
1. To develop a web 2.0 platform that will create an interactive podium for participation	i) Do web applications using interactive screens enhance public participation levels in the planning process in Uganda?
2. To test the application in a real world situation.	ii) Does the interactive platform influence data update and reduce inaccuracies in the data in Uganda?
3. To understand the community perceptions of space.	iii) Do technical representations of space have an impact in community understanding of spatial aspects?

Table 1: Research Questions

1.6 Hypothesis

The following hypotheses will be tested during the study:

If community participation levels increase then web applications using interactive screens are suitable approaches for enhancing participation in the developing countries.

If inaccuracies are reduced, community participation by using web 2.0 technologies with interactive screens is suitable for developing countries.

If the community members can understand the spatial features and map the features then they understand the display of the spatial features and elements.

1.7 Scope

1.7.1 Geographic Scope

Town planning is carried out in all parts of Uganda, by law the whole country is a planning area. (Physical planning Act 2010). The case study as illustrated in figure 3 below, Bugembe, lies in

the Eastern part of the country along the Jinja–Tororo highway about 4 km from Jinja Municipality, the second largest town in Uganda.

In the south, it is bordered by Lake Victoria, the largest fresh water lake in Africa, Mafubira Sub County in the north and east, Jinja Municipality in the west. The Town Council covers an area of approximately 7.63 sq km, with a gently sloping terrain, from which, a beautiful scenery of Lake Victoria is viewed. The region lies along 0º 28´ 03.29"N, 33º 14´ 12"E.

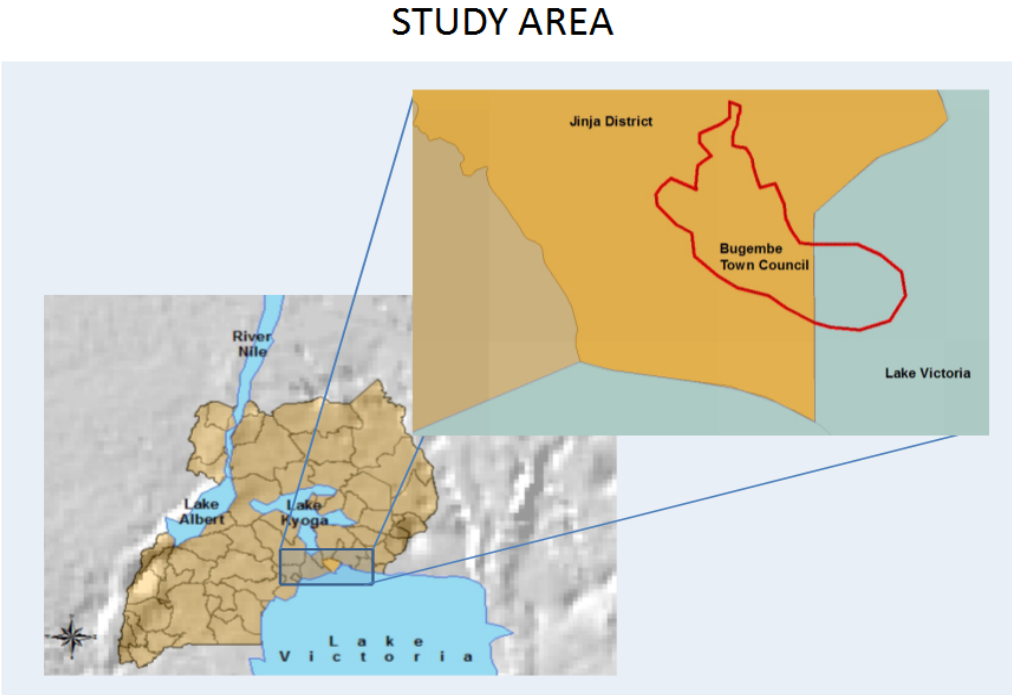

Figure 3: study area location

Bugembe Town council as an administrative unit, was established on 26th April 2008 as one of the three town councils in Jinja District, which was once the industrial hub of Uganda.

In the late 1930's, it was officially recognized as the seat for Busoga kingdom, *Obwa Kyabazinga bwa Busoga*[3], this dates back to the historical perspective in Uganda when the kings were the recognized leaders in the area.(Dongen, 2008)

In the 1950s, the town was declared a planning area following the then planning Act[4] and the first physical plan was developed in 1953 on a drafted tracing paper.

The town houses most of the retired civil servants in Busoga, especially those who initially worked in the administrative areas of Jinja district.

3 Kyabazinga is the title given to the king in the Busoga region or kingdom.

4 Town and Country Planning act 1951 was established by the British in Uganda

According to the Uganda Bureau of Statistics (UBOS), in 2008, the estimated population of the town was at 30,600 and in 2011; UBOS estimated the population of Bugembe at 33,100.

The town is made up of 5 administrative units/wards: Katende, wanyama, Nakanyonyi, Budhumbuli east and west.

The Town authorities sought the need to enhance orderly development in the town, since the town is fast growing with a high population growth rate of 4.5% per annum. Majority of the town population is comprised of female (51.6%) as compared to 48.4% male population.

The settlements in the southern part of the town council in Budhumbuli east and west wards have squalid developments which pose a health nuisance to the community.

There is an environmental threat in the town which is mainly linked to the disposal of wastes (solid) as well as domestic storm water. There is no properly established site for the disposal of waste water as well as a system of waste collection. Wastes are dumped along the roads, which leads to environmental degradation especially the non biodegradable wastes. The biodegradable wastes pollute the environment with bad smells. The open dumps are close to people's homes and they get filled up yet emptied irregularly. This has affected the environmentally sensitive areas leading to climate change and its adverse effects.

The initial structure plan prepared in the past is outdated and the new structure plan will seek to address the development concerns in the town.

A structure plan, which is a broad guideline, which shows areas in general terms for urban development. The urban physical development plan (physical planning Act, 2010), indicates the manner in which the land in the area may be used.

This study will therefore focus on the public participation stage where the community will be requested to make comments on the plan prepared by the town council using an interactive web 2.0 application platform other than the traditional methods of paper and pen that are often used in the country. The town council structure plan will be projected on to an interactive screen and the community comments will be sought.

Planning by definition is an exercise in imagining and shaping the future. Literature has demonstrated that the planner's role in shaping the future should not be limited to outcomes but extend to process. Planners should not stop at designing beautiful drawings on paper but also work for the plan implementation to enable the communities realize the benefits of planning. Planning as a process should be inclusive of the under represented, especially the women and children, engaging to the community from its earliest stages in the identification of the priority areas, and use technical and other tools to communicate trade-offs. (Chakraborty 2011, Rittel and Webber 1973)

Planning by nature is people centred, planning for culturally, socially diverse people requires planners to move beyond their reliance on technical and scientific methods and embrace different ways of finding information from communities that are experiential. (Sandercock 1998)

Although planning approaches are centred at reaching out to a large group of people, it is often difficult to obtain a suitable time and place to conduct participatory meetings for the whole community yet their input is very necessary for the development plans.

The scale of a planning process can range from a local community to a metropolitan region, county or state. Scales influence the participation approaches among locals, smaller geographic scales are known for producing enormous results in participation unlike bigger geographic scales where people will tend to shy away from participation.

1.7.2 Project Scope

The major goal of the study is to assess the influence of web applications using interactive screens in enhancing participation levels in the planning sector in Uganda while understanding the community perceptions of space. The project scope involves:

1.7.2.1 Developing a web 2.0 platform

An interactive platform will be developed using web 2.0 technologies, with the sole functionalities of data visualization, edit and save comments into a database. The necessary data layers will be collected and organized in the suitable format for the application. A Web 2.0 site allows its users to interact with other users or to change website content, in contrast to non-interactive websites where users are limited to the passive viewing of information that is provided to them. (Batty *et al* 2010)

Web GIS improved the application of traditional GIS through enabling the users on the client side to be the sole data providers. On a web GIS, the data and maps are accessible to anyone on a computer with an Internet connection. The advantage of web GIS over desktop GIS is that it is more accessible to the general public, as citizens do not have to install expensive software on their computer. (Ganapati 2011)

The web 2.0 will be used at a traditional participation meeting, where the community will gather at a central place and make comments on the displayed plan but this time, map directly on the interactive screen. Since public participation is a process, the communities need to be exposed to new approaches but at the same time combining them with the old procedures so that the gist of the approach is not lost with drastic changes.

Arnstein's participation ladder (Arnstein1969), figure 1 above, was further advanced to explain how participation levels are increasingly being influenced by technology advancements, as illustrated in figure 4. The advanced version emphasises increasing communication, leads to more interactivity as the online applications come into play creating two way information flows hence increasing participation unlike online service delivery, a one way communication approach which relates to non- participation component of Arnstein's ladder. The assumption is with increasing online discussions, there is increasing communication and therefore participation.

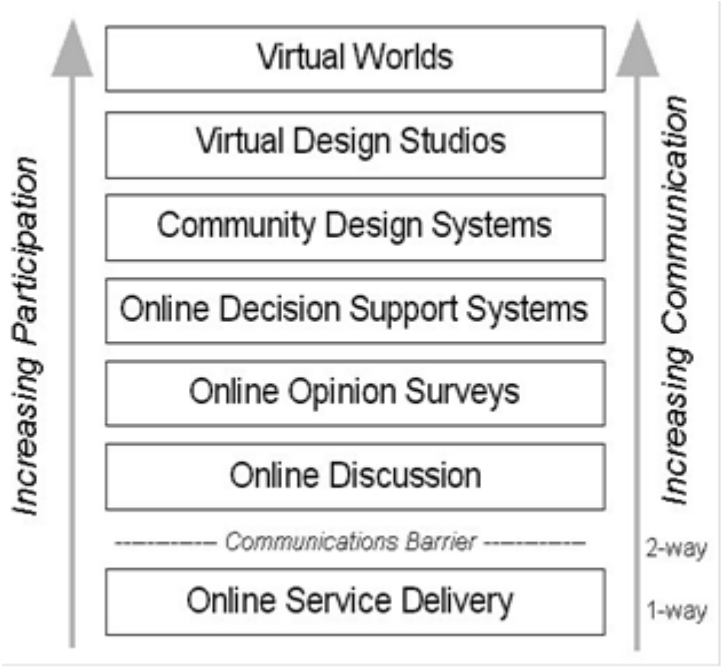

Figure 4: Advanced participation ladder (source: Carver 2001)

Public participation approaches that are technology oriented should follow steps and processes that are gradual and communities should be exposed on a step by step basis.

This study will therefore be based on traditional community meetings in a central location, the communities in Uganda are more used to these settings, and most of the people cannot access the application over the internet since they don't have computers and internet connections.

1.7.2.2 Evaluation of the web 2.0 platform

The application will be tested in a real world experience; the communities will be encouraged to make comments on the plan prepared and these will be mapped directly to an interactive screen. The application will be evaluated physically through observation to ascertain how easily the communities interact with the application especially if they can make any comments on the projection.

1.7.2.3 Usability assessments

Finally usability assessments will be conducted using questionnaires, where the participants respond according to their experience with the platform. Measures of satisfaction, efficiency and effectiveness will then be determined from the response. Physical checks are also done to assess the levels of interaction with the equipment, during and after the workshop.

The quantification of participation levels is complex. To understand the needs of the community in relation to applications that they use comfortably requires usability tests. Often people start

web browsing and quit the process prematurely, hence making it difficult to assess system usability.

According to Butler 1996: "System usability can be quantified in terms of users' performance and satisfaction during the interaction with the system". There are mainly two methods for evaluation of usability: inspection methods, for testing the levels of interaction physically and collecting feedback as users interact with the system. (Banati *et al*. 2006). Physical checks, video recordings will be done to provide an understanding of how the process transpired.

1.7.2.4 Community perceptions of space

The research covers lastly understanding the community perceptions of space; public perceptions of space are sought through the questionnaire, to understand their feelings about spatial representations of geographic features on the web 2.0 application. The community is also engaged in a mapping exercise in which they are tasked to highlight their boundaries and landmarks. This will enable the researcher understand how communities prefer to represent spatial features on maps for their easy orientation and understanding. Conclusions will be drawn to ascertain whether this has an influence in discouraging communities from participation.

1.8 Thesis structure

The structure followed as illustrated in figure 5 below, is in relation to the study goal of enhancing public participation and the procedures followed to achieve the objectives as outlined above.

Chapter 1, in the Introduction, the general perspective of the project is explained, to provide an understanding of the purpose of the study. The subject area is elaborated; expressing the originality of the problems and the background which enhances the motivation to carry out the research. The goal and objectives of this study are explicitly explained.

The project design that will be followed is illustrated especially in line with the objectives of the study to provide an understanding of the background studies as well as the choice for the study problem. The subsequent steps that will be followed in order to achieve the study goals are then illustrated. The geographic scope and project scope are elaborated as well.

In chapter 2, the theoretical framework is presented especially targeting areas of interest to public participation from the broad perspective and dwindling down to PPGIS which creates a basis for this research and study. PPGIS approaches are examined in the developed countries with advanced technological equipment and lessons are drawn from the experiences. PPGIS experiences in developing parts of the world are then examined to relate the studies to the research being conducted as well as borrowing ideas that are applicable in the Ugandan setting.

Literature about Town planning is revisited, to illustrate its significance in social-economic development, the significance that community participation portrays is considered. Studies on community perceptions of space are analysed to borrow ideas for the study being conducted.

In chapter 3, the methodology for the study is illustrated with specific consideration to the study objectives and research questions. The conceptual frame work provides a general understanding of the problem and the purpose of carrying out the study. The web application design follows a simple interface and a traditional community meeting is still followed. The steps to test the application in a real time workshop are explained in detail. The design processes and procedure are illustrated in diagrams for better understanding of the methodology used. The design methods are mainly centred at achieving the study goal of the research to enhance participation than to draw people away from participation.

The results are shown in chapter 4, this involves the results from the developed web application; illustrations of the workshop proceedings are shown in this section of the report. The results from the consultative workshops are elaborated giving analysis of the proceedings in the field work scenario.
The application is evaluated using questionnaires filled in by the participants during the consultative meeting, physical checks and recordings. The results from this evaluation are further analysed in relation to the study objectives.

In chapter 5, the results are discussed in relation to observations made, responses from the questionnaires and physical observations. The discussion is done in line with the hypothesis being tested to ascertain if the hypothesis and research questions are answered. A comparison is made in relation to studies carried out in the discipline of public participation, literature reviewed, to ascertain the level of consistency or contrast with this study carried out in Uganda and its contribution the discipline of PPGIS.

In chapter 6, conclusions are drawn about the study, analysing its impact in PPGIS in developing countries and above all its applicability in Uganda. Arguments are made whether the application enhances participation or it doesn't in relation to the results and analysis made from chapter 4. Recommendations are made for further research areas especially addressing the challenges that were faced during the research and the study workshops.

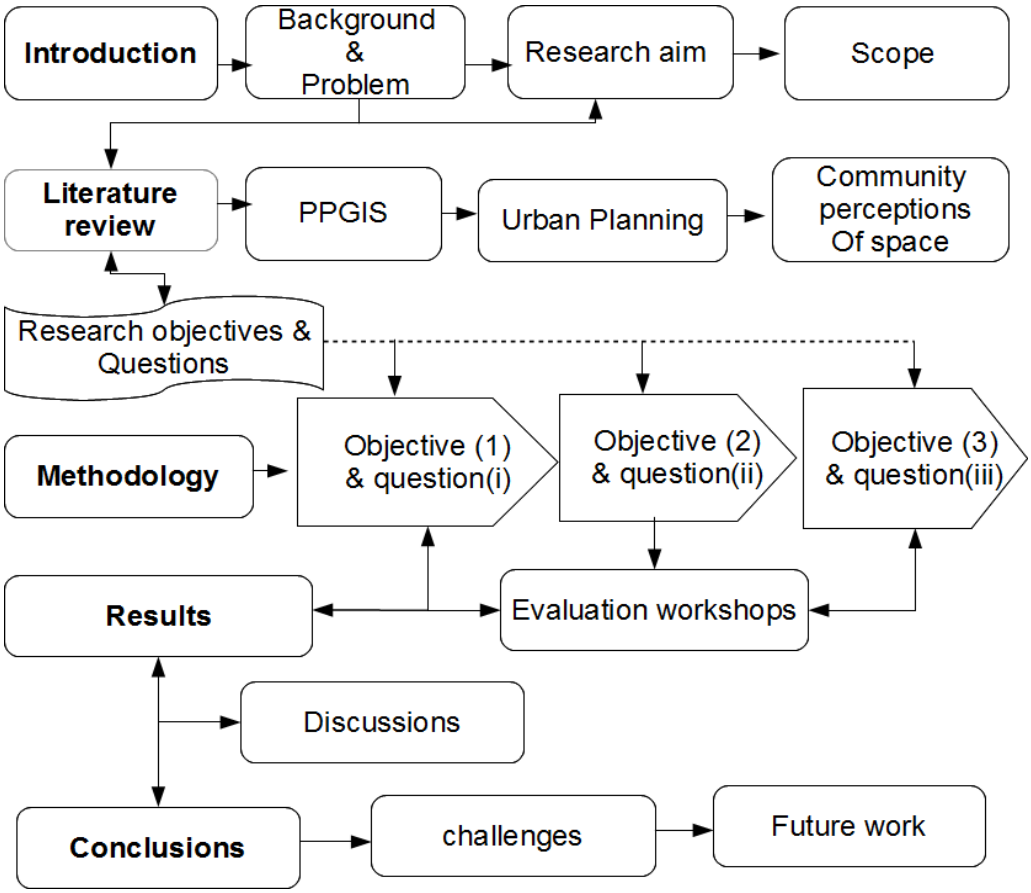

Figure 5: Thesis structure

2. RELATED STUDIES

2.1 INTERACTIVE PUBLIC PARTICIPATION, URBAN PLANNING AND COMMUNITY PERCEPTIONS OF SPACE.

Public participation approaches have caused a lot of interest in many disciplines, producing enormous results which have led to intensifying applications to "better" methods with motives of attaining even better results to phenomenon studied. From the town planning perspective, to plan for any community, there is need to understand how, when and where, to ensure that informed decisions are made that will stand the taste of time. The how, when and where are easily addressed by communities since locals understand their priorities better than any outsider, they are more familiar with their surroundings and have a better view of how their neighbourhoods should look like even in the future.

2.2 Public Participation

Public participation studies are rooted to the Arnstein's 1969. Public participation models have been designed to further guide the process and stages at which individuals should be involved.
The spectrum in figure 6 below, as a model of public participation from IAP2, looks at different participation levels in which communities should be involved. Five core aspects of participation are highlighted and the level of engagement increases from the stage of inform to empowerment. These different stages provide a basis for determining at which stage the community should take part in a particular level of the participation process.

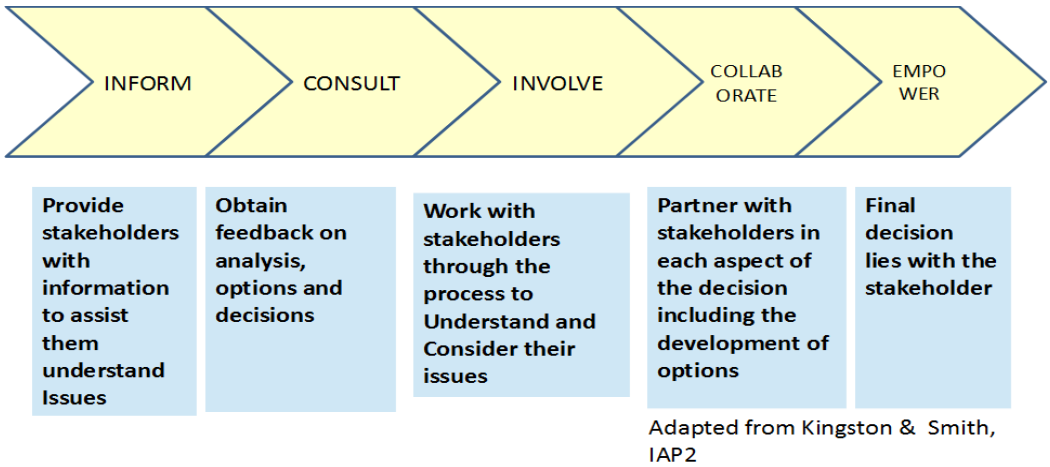

Figure 6: The spectrum as a model of participation

Davidson 1998, commented about the South Lanarkshire council's wheel of participation illustrated in figure 7 below, as a tool for promoting positive and responsive approaches for

developing partnership in public participation processes. He emphasised that the wheel enables authorities to go beyond the limitations of the traditional public meetings since they include opinion meters, software, techniques for planning of real time focus communal groups. South Lanarkshire council in Scotland, developed this model to improve the communication gap between the authorities and the locals so that areas that need emphasis are identified in the planning process. Many local governments are using these participation models to engage communities in decisions that directly affect their lives.

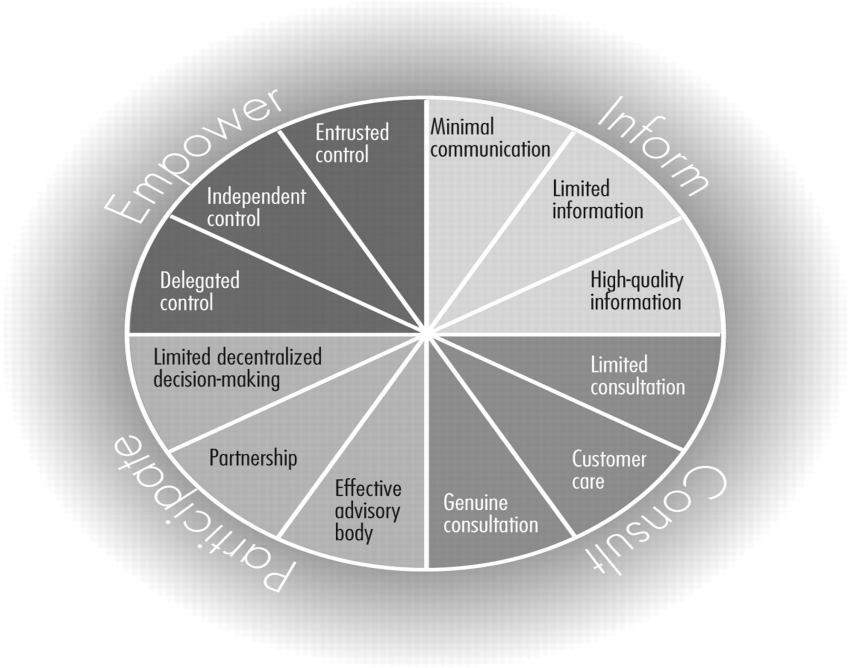

Figure 7: The wheel as a model for participation. (source: Davidson 1998)

2.3 Interactive Public Participation

Interactive approaches to public participation have increased over the years with the motive of encouraging communities to participate at their convenience and gain confidence that their opinions are highly considered. Public participation over the years was centred on traditional methods since technology was still in the early stages. Communities were involved in traditional mapping exercises for planning to demonstrate their ideal neighbourhoods and identify changes needed for development of these areas.

This trend was further uplifted when the term: "public participation geographic information systems" (PPGIS) was established in 1996 at the meeting of the National Centre for Geographic Information and Analysis (NCGIA). The meeting was intended to discuss GIS and society; the

social implications of how people, space, and environment are represented in GIS. It was from this meeting that numerous studies arose to guide PPGIS in all parts of the world.

Public participation GIS (PPGIS) in the broader context implies participatory mechanisms where the general public facilitated by GIS provide and make changes according to the subject under discussion.

According to Hacklay and Tobón 2002, "public Participation GIS (PPGIS) is a field of research that, among other things, focuses on the use of GIS by non-experts and occasional users. These users tend to have a diverse range of computer literacy, world views, cultural backgrounds and knowledge". It is from these non-expert users that geographic information needed is obtained to address issues in their jurisdictions. Communities provide an expertise in ideas or knowledge that is rich in content and relates to the subject being discussed, these rich contents would otherwise be omitted if these locals are left out of the picture.

2.4 Traditional GIS

Traditional methods of public participation involve the use of pen, paper, analogue maps; here communities have the opportunity to express their views either by way of writing or drawing. Mental maps have been cited as the best examples that involve communities, designing their ideal neighbourhood plan, by allocating places for various facilities. These methods though termed out dated are still interactive, interesting and exciting to communities since the locals directly influence the way their towns will grow in the near future.

Noticeable are the wide range of advantages that these methods present ranging from being readily available, cheap to flexible, however they come with a wide range of complications.

Al-Kodmany 2000, argues that, the main drawbacks of freehand sketching are that it is limited in presenting information about the current context of the planning area, and it is not highly interactive.

2.5 GIS and the Internet.

GIS where internet is the medium of transition became popular since the 1990s, the trend has grown over the years. "Citizens can view the maps in real time with dynamic data queries. The interactive features of web GIS, such as querying, searching, and mapping dynamically on the fly, have further expanded the use of GIS for citizen participation" (Kingston 2007, Tang and Waters 2005).

Technological advancement in the GIS field has contributed to productivity in all sectors as a multidisciplinary approach especially in relating things that would be totally unrelated. "Using the medium of Internet, GIS systems can be developed to address the notions of democratization with respect to spatial data and decision-making processes, open accessibility, and an effective distribution of spatial information"(Boroushaki and Malczewski 2010, Hanzl 2007).

Al- kodmany 2000 adds that the Internet has already proven to be valuable on its own as a low-cost mode of communication for participatory planning though Web sites, e-mail, surveys, and online conferencing. In particular, Web-based GIS and Web-based virtual reality are becoming two new frontiers for visualization in public participation planning.

GIS and the internet have advanced the approaches used in PPGIS, however, the methods and interfaces for web applications are often complicated for a number of users. As a result people tend to shy away when faced with unfamiliar technology. "Web-PPGIS practitioners need not only upload a Web-PPGIS to a Web site, but also must design it in an effective, efficient, and satisfying way for users to perform specific tasks."(Meng and Malczewski, 2010)

2.6 The web 2.0

The need for more interactive means of public participation, advancements in technology and the use of the internet led to the birth of web 2.0 applications in 2005. The term 'Web 2.0' is commonly associated with web applications that facilitate interactive information sharing, interoperability, user-centred design, and collaboration on the World Wide Web. A Web 2.0 site allows its users to interact with other users, sharing web content or to change website content, in contrast to non-interactive websites where users are limited to the passive viewing of information that is provided to them. (Batty et al 2010, Goodchild 2007)

Web GIS improved the application in traditional GIS through giving capacity to users on the client side as the main data providers. The communities participate at any time, place through a few clicks and browsing. The data and maps are accessible to anyone on a computer with an Internet connection. (Ganapati 2011, Krygier, 1998, Batty 1997).

The ability to keep users anonymous made Web 2.0 preferred over the traditional methods. A Web-PPGIS enables people to express their views by posting comments in a relatively non-confrontational manner while relating the information provided by other users. (Meng and Malczewski 2010)

Web 2.0 is an innovation from the web 1.0, latter not only provided information from the programmers, but also in static formats, browsed according to the "experts" design, centering on the expert's choices.

While map-based communication have traditionally been unidirectional, universal online base maps and associated application programming interfaces have paved way for the emerging cadre of 'neo-geographers' to democratize map production to the extent that the distinction between map makers and map consumers has blurred (Turner 2006, Gartner *et al* 2007, Hall *et al* 2010, Goodchild, 2009).

Web 2.0 is interactive and designed basically for the local person with limited or no GIS knowledge to feed in their views and opinions. Web 2.0 comes with outstanding significance, (O'Reilly, 2007) shifting the Web to turn it into a participatory platform, in which people not

only consume content (via downloading) but also contribute and produce new content (via uploading). In the web 2.0 applications the users are no longer on the receiving end but rather the major contributors of the knowledge base.

2.7 Low Technology or High Technology

The level of technology greatly influences the levels of participation, prior knowledge about the community and their past experiences in participation is important and a guiding factor, whether to have low-tech or high -tech methods. Al-Kodmany 2000, argues that, "many stakeholders in urban planning are lay persons with varying amounts of experience with computers. The simplicity of many of the traditional methods can instil confidence and encourage people who retreat from technology to participate. Tools such as pen and paper sketching, paper maps, photographs and physical models draw forth high levels of participation and input from the participants".

Arias 1996, suggests that, "real-time social interaction among neighbours surpasses computer simulations even when they have user friendly computer interfaces. He adds that computerized methods lose their advantages when people have to work the computer.

There is no knowledge base that is a prerequisite for participation. Participants do not need to know how to move a mouse, for instance. The low technology methods generally carry a lower price tag, which is a prime consideration for many community groups. It must be acknowledged that the computerized tools may simply be out of reach for many organizations.(Al-domany 2000)

However the low technology methods present a number of disadvantages which makes their choice highly questionable, they lack competency in handling large volumes of information; they lack functionalities like formatting the data easily and retrieving it, which functions are relevant to any GIS environment.

In the Geo-spatial environment, GIS offers a wide range of applications which turn the data into meaning. Spatial analysis is an outstanding application that the GIS benefits from unlike the other computer systems and worse still with the low technology methods.

However, the high technology methods if not well used, discourage participation among the communities as they may be misleading and difficult to interpret. Al-Kodmany 2000, emphasizes that when choosing a computerized method for use with the community, it must be as simple and less intimidating as possible in order to facilitate a high degree of involvement. He adds that "It is becoming widely accepted that in communicating planning ideas, the form of representing the information is as important as the information itself".

According to Marsden 2009, Africa has been largely referred to as the least in technological development and use as shown in figure 8 below, yet the technology in Africa is sufficient for citizens to work with in the means.

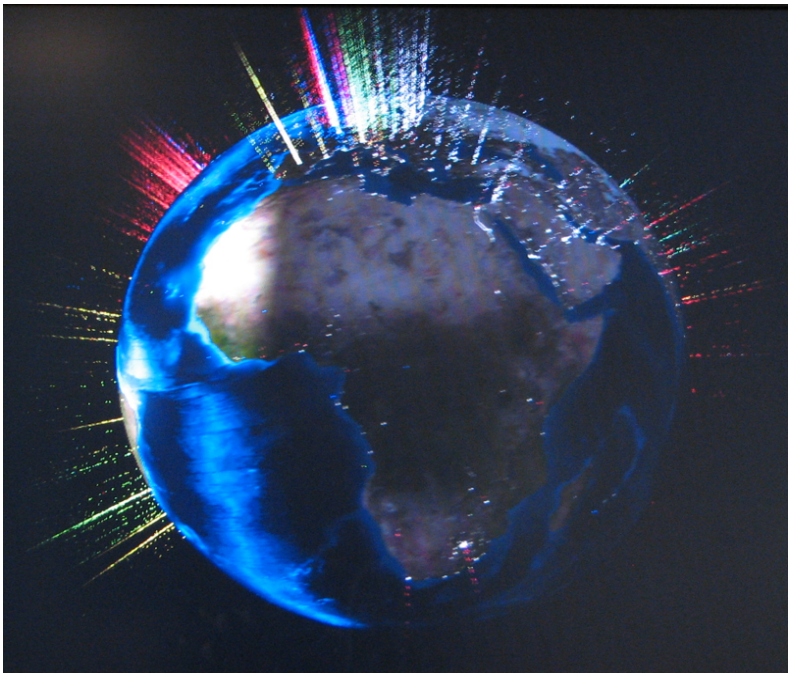

Figure 8: Google searches across the world .(source: Marsden 2009)

He explains that Africa has been referred to as technological 'wasteland[5], the cost of technology is much higher in Africa than in developed countries. He emphasises on the need to have systems that extract more functionality than having new designs.

2.8 Interactive Public Participation in Practice

Interactive public participation applications have been widely used around the world and the efforts have shown tremendous results which have led to the continuous improvements in the approaches used in the public participation studies.

Traditional methods of participation although termed out dated, provide a learning ground for improving methods being tested, it is from these experiences that adjustments are made to enhance participation. These methods still play a significant role in PPGIS especially in communities where technology advancement is still very low.

Examples for the study have been drawn from all parts of the world to create an understanding of the methods initially used, what is currently used, how and for which community. These examples provide ground for the study strategies to be put in place in Uganda.

5 According to the google searches, the length and the intensity of the coloured lines represent how many searches are happening at that instant in that place in the world.

In reality check lessons to enhance participatory planning in Washington DC in figure 9 below, coloured Legos were used to map the anticipated growth in terms of jobs and in the housing sector for each grid with a unique ID.

Figure 9: Reality check lessons in Washington DC. (source: Chakraborty 2011)

These predictions were later entered into a data base for further planning exercises and the development of the neighbourhood. The gist is in the simplicity of the method used; legos, children' favourite play toy, to create a friendly environment while encouraging the community to participate.

In most developed countries, the traditional mapping exercises are no longer widely used firstly because of the advancement in technology and secondly it is not always easy to have the entire community gather in the same place and time. Web applications have therefore taken course in most of the studies, with the wide internet connections.

Web technology has changed over the years as described in table 2, with web 1.0 commonly used in 1995 and earlier years, web 2.0 in 2003 and web 3.0 in 2008, all ranging in applications for different uses.

Web 1.0	***Web 2.0***	***Web 3.0***
10 million users	100 million users	Billion users
Pushed web	Two way web	Real time web
Text and graphics	Email, audio, video, wikis, blog, social networks	Avatar representation, media flows and virtual worlds
HTML, XML	AJAX, RSS	Web semantics
Content consumers	Content shares	Content interoperability
Slow connections	Fast connections	Ubiquitous connection
flash	2D	3D
>1995	>2003	>2008

Table 2: Web changes over the years (source: Geisa et al 2010)

Public participation web 2.0 approach in Canela Brazil developed by Geisa et al 2010, in figure 10, was used to address planning concerns, the community made comments on planning topics using makers to show the different colours for different planning topics. The meeting followed a traditional method where the whole community gathered and commented about the planning topics from computers installed with the application.

Figure 10: Public Participation in Canela, Brazil. (source: Geisa et al 2010)

The application was literally translated in Portuguese so that the local people could easily find their way around the application.

The Woodberry online public participation experiment[6] by Hudson-smith et al 2002, was used to engage residents in making suggestions for a housing scheme, to improve the housing conditions in wood berry down estate in the London borough of Hackney. The participation was categorized into two forms; an exploratory platform was placed at a school for the community to make comments while there was an online version which expressed the feature development of the area in 3D and the locals were encouraged to comment and a make a choice of their preference. The approach here is a combination of both traditional methods where those who can't access the

6 Http//hackney.gov.uk/woodberry/

application on line have the opportunity to make their comments at a deposited version of the application in a school.

The beauty in the method is that a large group is reached on line and also in the traditional meeting. The site provided the locals with options to chose from, the alternative plans were pre designed, participants made a choice of the most desired neighbourhood and submitted it to the authorities.

Hudson-smith et al 2007, looked at studies of second life in web 2.0 applications[7], as shown in figure 11, a Map Tube was designed as an environment where users created maps, viewed them and engaged in simple manipulation using the time-honoured method of map overlay. The users could share these maps with other users. Such experiences enable the users to have confidence that their comments are considered

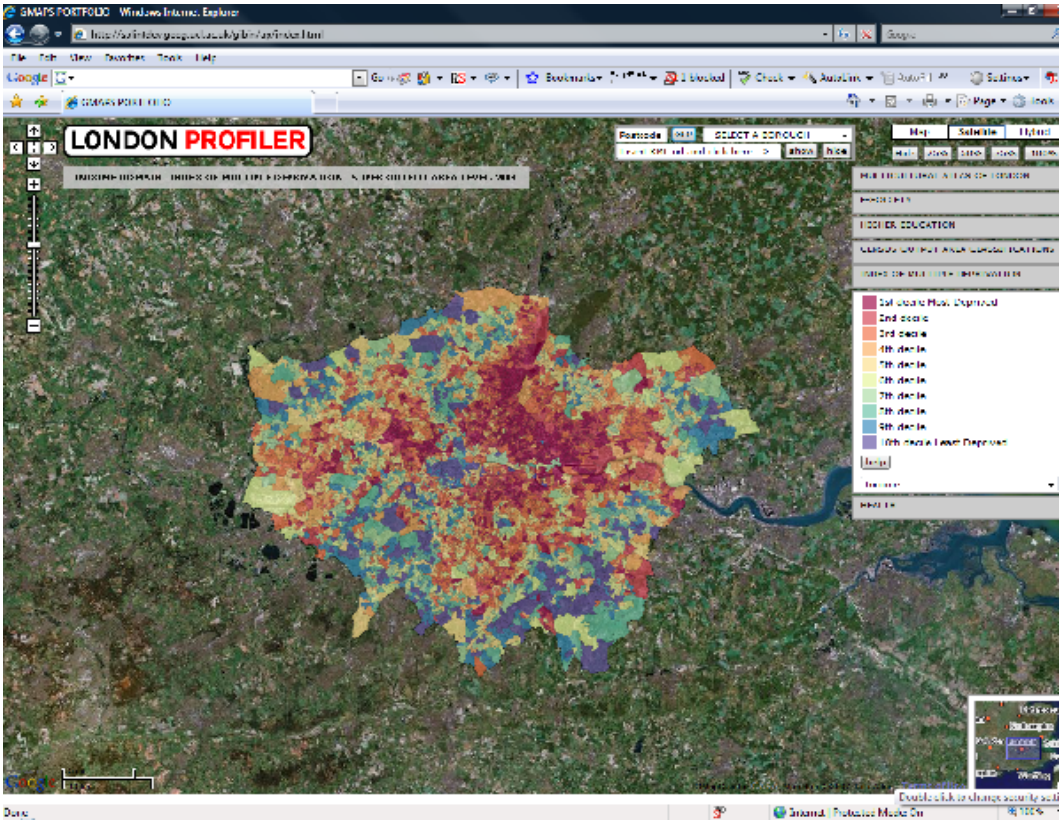

Figure 11: Using Map for second life web 2.0 application. (source: Hudson-smith et al 2007)

2.9 Interactive Public Participation in Practice in Africa

In South Africa, Weiner and Harris 2007, examine how GIS plays a central role in how people view their physical resource base and exploit it. The study was based in Mpumalanga Province

7 http// the London profiler.org

which was undergoing transition in environmental features, facing rapid per-urbanisation and recovering from the apartheid forced removals. The multimedia CiGIS application developed was based on providing a platform for identification of potential land reforms. The method was a combination of traditional GIS methods where the base data was mapped on tracing paper and later on digitized and integrated in the CiGIS. The mapped data included how groups would use any land allocated through land reform.

Kyem 1999, in his study of promoting local community participation in forest management in southern Ghana, encourages the community to use GIS in the management of the forest resources. The meeting followed the traditional method of central communal gathering. The women and men were engaged in groups to discuss and map ideal land uses. The use of GIS helped to merge ideas and thoughts of the various groups into a common vision. He discovers that the PPGIS method he used provided a mechanism for harmonising multiple view points, it helped the participants to develop a common sense of mission for the protection of local forests.

Auma 2012, in her study of integrating community participation for urban redevelopment planning in Zanzibar, engages residents in mapping their ideal neighbourhoods using paper and pen as shown in figure 12 and 13.

Figure 12: Communities map their ideal neighbourhood

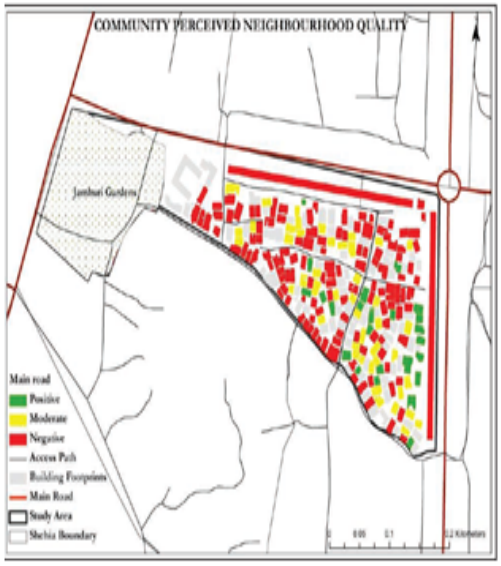

Figure 13: The community mental map is digitised

2. 10 Urban Planning

Public participation is significant in urban planning since all the planning approaches are directly based on opinions that communities make in their societies to improve the development of the area in which they live, work and relate with each other. It is therefore no doubt that most of the public participation approaches in one way or another are targeted at addressing town planning concerns regardless of the geographic scale of operation and the time frame.

Urban planning studies are rooted back to the mid-19th century of the industrial revolution era which led to health nuisances due to the haphazard developments. Urban planning was therefore a means to combat the un healthy environments and create orderly and aesthetic environments. Most countries developed health acts to address the nuisances and most of the content was directed at how town planning would address these threats in one way or the other.

Planning approaches have changed over the years, as shown in table 3, as time passes by, different skills and approaches are used that best suit the situation and circumstances around.

Decade	***Planning theory***	***IT***	***GIS***	***PPGIS***
60´s	Applied science: IT as resource to a rational, objective planning.	Data and electronic data process		
70´s	Politics: IT as political tools, reinforcing existent power organizations.	Information and management system.		
80´s	Communication: information distribution ways with great value	Knowledge and decision support system	GI Systems	
90´s	Reasoning together: IT as tool to enable discussion and communication.	Intelligence	GI Science	PPGIS
00´s	Participatory Planning	Collective, social data.	Voluntary GIS	Web PPGIS

Table 3: Planning theory, IT and GIS (source: Geisa et al 2010)

Communities are central in the planning process, planning for culturally diverse populations will require planners to move beyond their reliance on technical-rationality and scientific methods to embrace different ways of knowing that include experiential, intuition and local knowledge (Sandercock 1998, Dragicevic and Balram 2004, Myers et al 1995).

Planning is an exercise of mental mapping to shaping areas in the future. “Literature has demonstrated that the planner’s role in shaping the future should not be limited to outcomes but extend to process. Such a process should be inclusive of the under represented, engaging to the community from its earliest stages, and use technical and other tools to communicate trade-offs”. (Chakraborty 2011, Rittel and Webber 1973)

Although planning approaches are centred at reaching out to a large group of people, it is often difficult to obtain a suitable time and place to conduct participatory meetings for the whole community. Most residents in an area are considered stakeholders, scale is a great determinant of the many factors that limit who should be included or who shouldn't. (Chakraborty 2011)

Planning in Uganda is highly participatory, taking on the bottom – up approach. Communities are central in the process, they are the driving force behind the development plans, their opinions are sought from the initial planning stages and mapped, the output is later presented to them for further consultation until the plan is ready for implementation, as shown in figure 14. In the planning meetings the traditional paper and pen methods for obtaining community comments are still employed as shown in figure 15.

Figure 14: Public participation meetings in Uganda

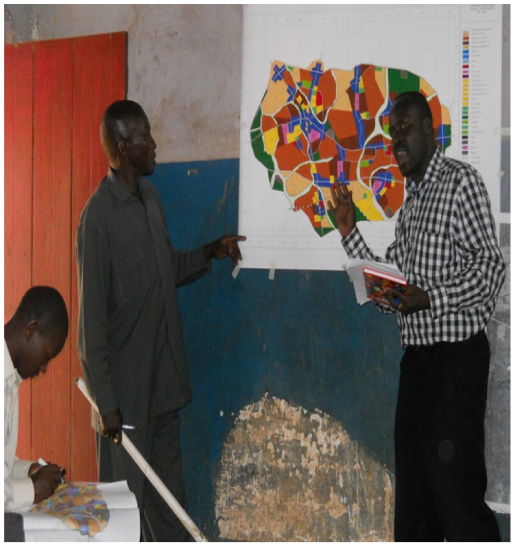

Figure 15: Community members make comments as a planner takes notes of comments.

The planners takes down the comments on paper, incorporate these comments into the digital plan at a later stage. This method comes with a vast range of advantages ranging from easily available to flexibility but also a wide range of challenges await both the planer and the community, in terms of double efforts of data entry, errors from estimations and difficulties in data sharing as the planner has to adjust the comments fast before giving out the required information.

2.11 Community Perceptions Of Space

Professionals have different ways of representing spatial features, a road, for example, means differently to a town planner, cad-astral engineer, road engineer, and surveyor. For some, a road is just the carriage way, while for others it includes the utilities lines, drainage channels, the pedestrian precinct and the cycle lane. This therefore influences the way the road is represented on maps that are presented to communities (Talen 2000, Harris and Weiner 1996, George 1997). There is need to seek standard ways of design and representation of spatial features, cartographic standards are at times difficult to interpret even for the lay persons.

A South African community of Mpumalanga, (Weiner and Harris 2007) was tasked with mapping and identifying areas for land reform as shown in figure 16. In the exercise they

represented their perception of the space they live in and the ideal land reforms. Community metal maps provide a rich ground for understanding their perceptions of space and how planners can incorporate these features in the neighbourhood plans.

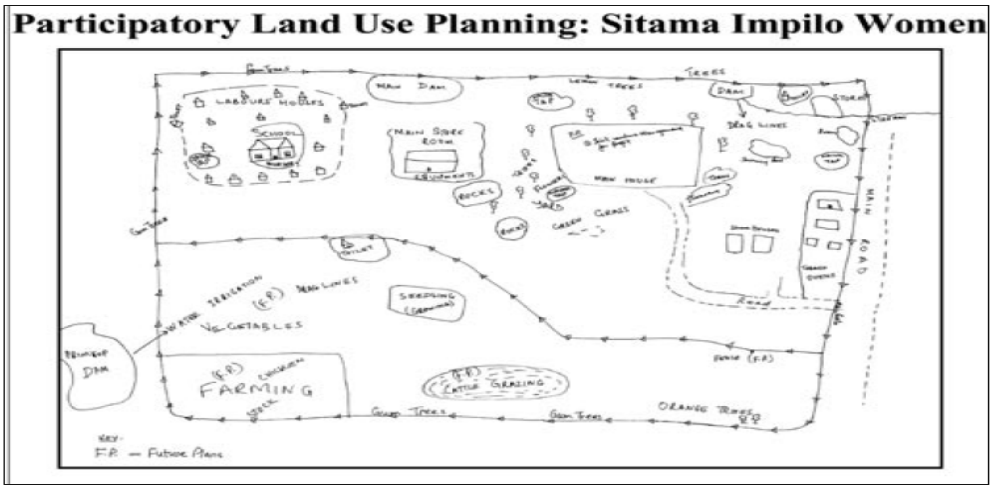

Figure 16: The women's metal map. (source: Weiner and Harris 2007)

A research conducted by Panek 2011, in Nairobi Kenya, was geared at PPGIS and understanding the community perceptions of space in different age groups for purposes of slum upgrading in Kangemi slum. Children (figure 17) were involved in an interview to map areas that they considered unsafe in the slum setting and the coordinates of these areas were picked, added into a GIS environment to produce the final map for slum upgrading strategies as shown in figure 18.

Figure 17: children map the unsafe areas, these location are later picked by GPS. (source: Panek 2011)

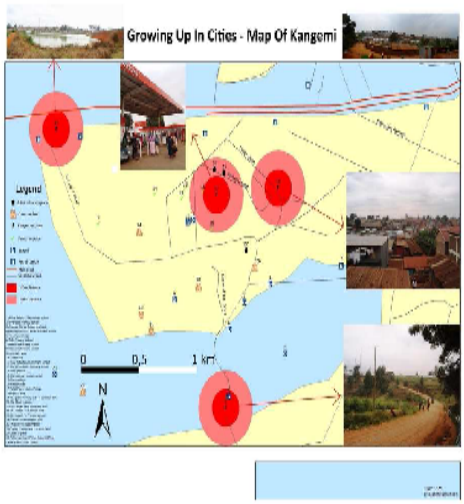

Figure 18: Final map showing the slum areas and their insert pictures. (source: Panek 2011)

3. METHODOLOGY

3.1 CONCEPTUAL FRAMEWORK

The conceptual frame work gives an ideal and illustration of the theoretical framework discussed in the previous section of related studies. The conceptual frame work explicitly relates to the research aim and objectives of this study.

To demonstrate the significance of the study, the thematic lines as suggested by Ganapati 2011, were used to relate to the study aims and create an understanding of the methods proposed for the study.

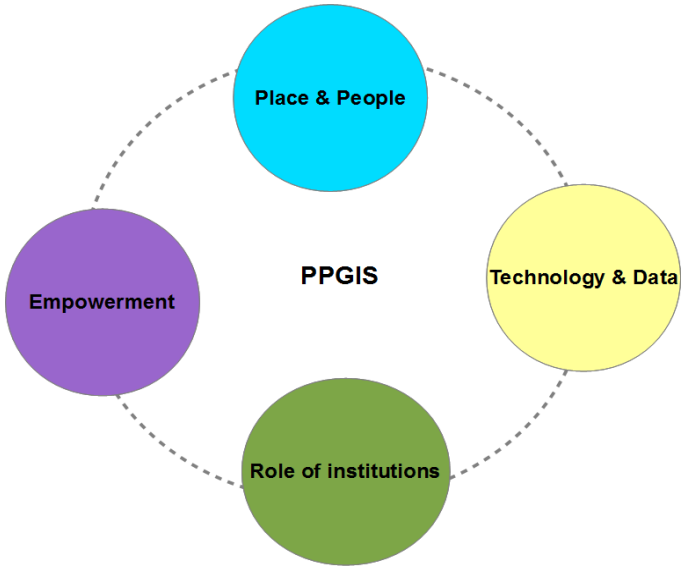

Figure 19: The thematic lines in PPGIS. (source: Ganapati 2011)

Figure 19 above illustrates that PPGIS is based on 4 themes, place and people; this relates to questions about which place will the PPGIS study be carried out from, who are the people and what cultural and social setting do they live in. In the theme of technology and data; which technology will be used and data, is the technology data driven or vice versa. It is important to understand the people and the level of technology they are used to, other wise the PPGIS process deviates from the intended objective of enhancing participation as many people tend shy away when faced with unfamiliar technology. The third theme of; the role of institutions, looks at the position of the authority and institutions in enhancing community participation. Finally empowerment; involves making the local people in charge and in control of decisions that affect their lives.

3.2 Research Design

The methodology for carrying out the study, designing the web application and the equipment that will used to do the relevant steps is entirely based on simplicity to create an understanding of the steps followed and the applications that will be developed for future related studies. The methodology that will be used is illustrated in figure 21 below.

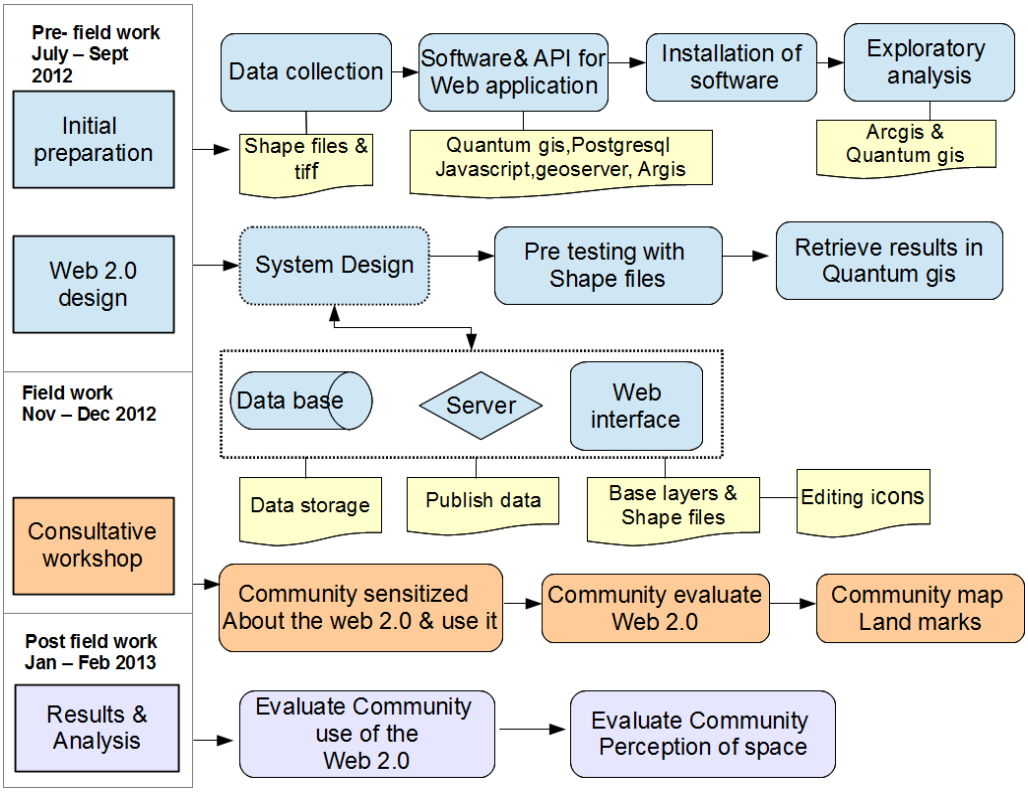

Figure 20: Methodology adopted

3.3 Data Preparation

The data preparation process involved collecting the required data for the study, the prepared town council plan will be used for the study purpose since the workshop will be targeting a consultative meeting about the proposals made in the plan. Data collected for the web application was the administrative boundaries. The data is required for the study to provide a base background and enable better understanding of the area in terms of orientation. The details for the data used are shown in table 4 below.

Exploratory analysis and data cleaning were then carried out to have a general feeling of the data and the required shape files were selected. The data was visualized in ArcGIS software, licensed software, then clipped to cut out the required shape file area for the study area.

Name	*Type*	*Scope*	*Mode*	*Format*	*Geometry*
Parish boundaries	Administrative	Regional and Local	Vector	Shape file	Polygon
Road network	Infrastructure	Regional and Local	vector	Shape file	Poly line
Lakes, rivers, swamps	Environmental	Regional and Local	vector	Shape file	Polygon & Poly line
Land uses	Planning proposals	Local	vector	Shape file	Polygon & Poly line
DEM	Elevation	Worldwide	raster	tiff	pixels
Google, open street, maps	Base map	worldwide	raster	tiff	pixels

Table 4: Data for the study

3.3. 1 Data Transformation

The shape files are then transformed to the geodetic datum so that they can be over laid on the base maps to provide a better visualization for the end user. The data was transformed to make it compatible with the base layers like Google maps and open layers, the data was transformed to EPSG;4326 which is the standard coordinate reference system.

This was done to ensure that the data align very well when visualized in the web application. The data was obtained in the Arc 1960 UTM zone 36N datum and had to be transformed to the geodetic datum.

3.4 Functional Design

The design procedure and steps followed to accomplish the study objectives and goals are explained and illustrated in this section of the report. The major goal is to design a platform for interactive public participation where the community can map and make comments directly on the interface.

These comments and changes made are then saved to a database on the server side of the application. The town planner can later retrieve the changes and comments for further analysis and plan development.

The design is further arranged in the following steps shown in table 5.

No	*Tasks*	*System requirements*	*Data requirements*
1.	Web 2.0 application – system interface	- Web server - Web feature service - Web features service transaction - Help and directions - Map control - Zoom and pan	- Base map layers - Administrative area shape files
2.	Editing and comments	- Icons for editing - Save functionality	- Open layers icons - Planning area data
3.	Data storage and retrieval	- Data base	- Planning area data
4.	Testing and evaluation	- Web page	

Table 5: The function design requirements

The platform is designed using a simple interface to encourage participation than drawing people away from participation. The application is designed on a server to enable visualization of the data in the application.

- Base maps of Google maps, open street maps and Google satellites are added in the background for purposes of better orientation and viewing.
- Map control functions enhance the ability of a person to zoom and pan around the map for better visualization.

The editing icons enable the users to identify which function they need to carry out, for example picking an icon to perform the desired action. The icons are for:

- Drawing points, lines and polygons
- Deleting icon to enable the users to erase any mistakes made
- Modifying the geometry drawn.
- Save icon for storing the changes made in the application in the database.

In the data storage and retrieval component, the data is saved in tables for only vector data thus points, lines and polygons.

This data is then retrieved in a software application for further spatial analysis by the planner.

The application will be tested and evaluated in a real life scenario to ascertain its relevance in public participation in a developing country. The major aim is to see how the community easily interacts with the application and whether it will enhance participation in the new environment being the first of its kind in the area.

- The traditional community meeting will be used instead, since the locals are assumed to have limited access to internet and computers at their homes.
- Presentation of the application will be made and the community will be asked to make comments on a displayed land use plan for their locality.
- These comments will be captured directly on an interactive screen using an interactive pen upon projection.

3.5 Technology Requirements

The application is developed using on open source software since the software has a wide range of advantages over the licensed software.

- The software are free and readily available for download and use on any operating system and computer applications.
- There are a number of learning tutorials which are easily available for use even if one has basic knowledge in the programming language.
- There are a number of forums in which consultations can be made in case one is stranded; responses are given from other users for immediate intervention.

3.5.1 Server

Geo server which is well known for its interoperability with other servers and programming languages was used for visualizing the base maps in raster format and the web features in vector format. The vector data was published in the geo server 2.2 with a connection to the database so that the edited changes could be saved to the database.

The programming language used was JavaScript. It is very easy to learn and has simple basics which can be followed to develop an application. JavaScript was used mainly in the development of the client side application.

3.5.2 Map visualization

Google maps, Google satellite and open street maps are the commonly used base maps in most web applications. These base layers provide a platform for easy familiarization of an area even when the person is new to map reading and GIS web applications.

These base maps are used in the background to enable the users easily orientate themselves when using the application. Most humans find it easy to read a map that shows them the exact picture in real world of an area.

The base layers present the world in an easy way for manipulation and usage. Google maps have terms of reference for copyrights, the source code and data cannot be used for any commercial purposes. (Geisa 2010)

3.5.3 Editing tools

These are developed using icons from open layers, there are a wide variety of icons to choose from, for map editing. These icons are easy to use and provide a user friendly interface making any person understand what the icon represents even before they use it.

3.5.4 Data base

Postgresql is used for data storage and retrieval; it is renown for handling vector data thus points, lines and polygons. It comes with a connection of postgis which offers functionality for the geometry data capturing and storage. The data can be entered and retrieved in the postgresql environment through the command line or through a graphical interface that is easy to use.

3.5.5 System design

The web application is accessed through a http (hypertext transfer protocol) request from the client side opening up a dynamic application for browsing as shown in figure 21 below.

At the interface display, from the client side, the user can visualize the different icons for editing, pan and map control. The base layers can be changed as well as switching on and off the web feature service.

These user requests are sent to the server through the JavaScript, the web services receive the request and send them through the data access which is later channelled to the database for quick action. The action could be adding point data and when the changes are saved, the response is sent back from the data access to the web services which eventually use the data transformation to interpret the data in the way the client side can read it. This transformation is then sent through the server and back to the user interface where the user can see the changes made. In the posgresql the spatial data is organized according to its geometry and spatial reference identifier[8] (SRID), attribute data as well as the events such as mouse movements, zoom and pan among others are also stored in the data base.

8 The SRID (Spatial Reference System Identifier) is a unique value used to unambiguously identify projected, un projected, and local spatial coordinate system definitions. Wikipedia 20th December 2012

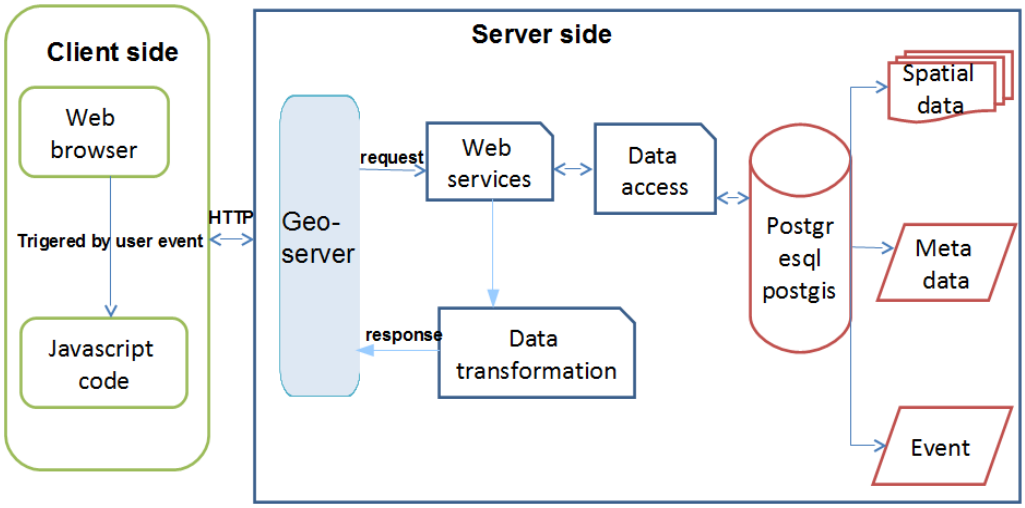

Figure 21: The system design

3.6 Implementation

The implemented version of the application was developed on a geo server to enable the community make comments over the user interface and save the comments in the database.

3.6.1 Development environment

JavaScript is the basic programming language mainly used in developing web applications. This was done using geo server which is very compatible with spatial data and spatial features.

3.6.1.1 Data base

The database is the storage mechanism for the data, it was the starting point for the data entry into the application. Postgresql which comes with postgis was used for data storage. The data was entered into the database through the command line using the shp2psql command, to create an environment that is understandable to postgresql.

It is important that the data is transformed into the way postgresql understands it and in a way that the shape file data will later be displayed in tables in the database. The transformation is then ended with the pgsql command which does the transformation into the table format in postgresql.

There is a graphical interface for the data loading using the pgAdmin which comes with the postgresql, this offers a very simple interface for the data upload, however it does not have the functionality for transforming the data in the format that postgresql understands, therefore the command line was used for this functionality.

The data in the database requires basic functionality:

- The table name in which the data will be saved
- The database name to be created for later retrieval in the geo server

- The spatial reference identifier SRID is very important in the data loading process and this is the transformed data ID that is used to transform the data in the database
- The shape file that contains the data.

The data is then viewed in the graphical interface of the database in the tables created during the command line operation. This data in the table format can be queried for any spatial analysis.

3.6.1.2 Publish the data in the Geo server

The data from the database is then published in the Geo server through the connection of the database. The publishing can be done in a group for multiple layers or individually for one layer. The Geo server provides the opportunity to visualize the layers as open layers or as KML files. The geometry of the table should be clearly displayed for easy publishing in the Geo server.

3.6.1.3 Web application

The application is built on the java script and the base layers are set as background data to enable overlaying the vector data. Figure 22 below shows the interface for the application, the editing tools and base layers.

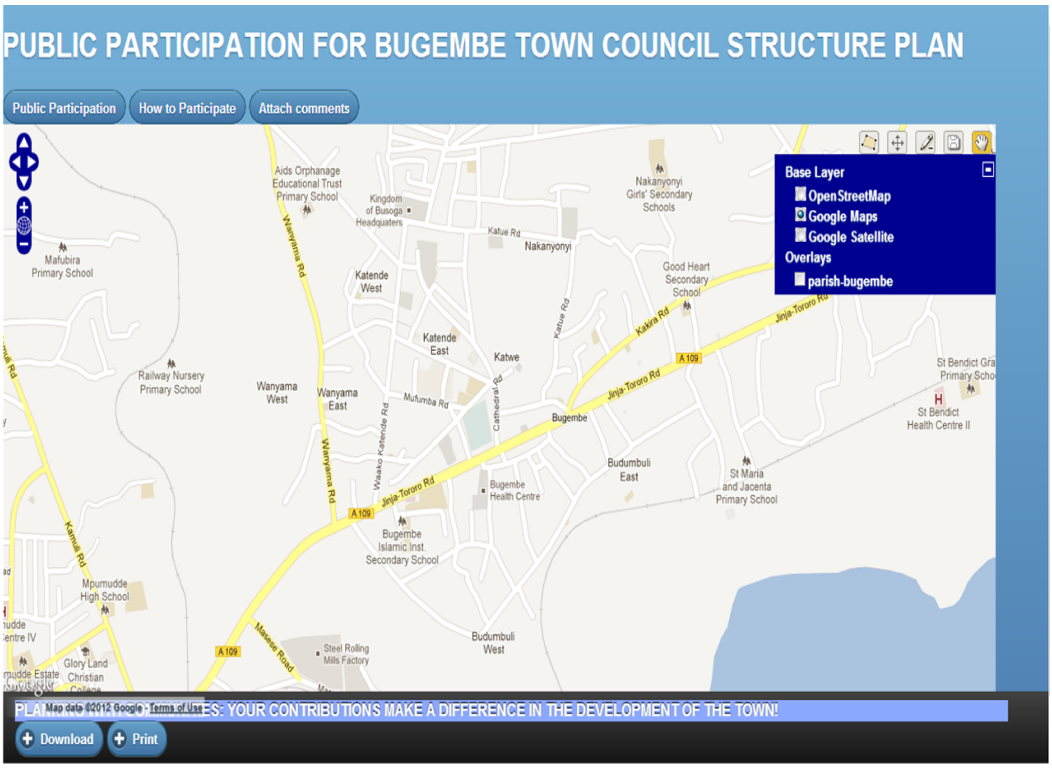

Figure 22: The web interface

The following additions are made to the web application interface:

- Open layers are used for the icons. These are styled in the cascade style sheets
- The web feature services are then added, the specifics used to publish the data in the geo server are considered closely in case of any mistake the vector data will not be published.
- The base layers are added in the script for background data.

3.6.1.4 Retrieval of results

The website changes can be retrieved through quantumgis through the postgresql extension from the producers side and these changes can be further used for planning adjustments by the planner.

3.7 Application Testing and Evaluation Workshops

The testing will be done in a local community in Uganda; Bugembe Town council, which has prepared a structure plan to guide developments in the town. The community will be requested to attend a consultative meeting about the plan to which their comments are required during the meeting as a planning regulation in the participatory process.

Planning regulations in Uganda require that communities are the driving forces behind any plan prepared because the implementation of the plan is entirely their responsibility. When communities are involved from the initial stages, plan implementation becomes much easier since they gain the notion of ownership of the plan from the initial stages.

The evaluation workshops will follow the traditional GIS methods of communal gathering in a central place; the community will involve people from all works of life, elites and non-elites. With this nature of community we can not have the application accessed from homes using laptops or computers since majority of the people don't own these hardware and don't have access to internet.

Carver 2001, suggests that GIS should not only be used with the internet but with intelligent interfaces to a specific problem which are exploratory, allow interaction between users and the computer, view other users opinions and share with a wider community. He views GIS with only the internet as a "complex beast" which dejects community from public participation.

The essence of the study will be to analyse the impacts of the web 2.0 using an interactive interface for public participation in a community like Uganda which has always followed the traditional methods of note taking of the comments.

The workshop will therefore entail a combination of the traditional GIS methods and the web 2.0 technology but this time round the comments will be captured directly on the interactive screens to improve the accuracy of the data captured, save time and double efforts which otherwise the planner would have to spend while re- entering the comments made by the community after the meeting.

The following questions will be asked to the participants for usability assessment to understand their experience with the application and assess its impact in enhancing public participation in Uganda.

The system usability scale (Brooke 1996) was considered for deriving the questions below in table 6and7. These questions were rephrased to suit the study aim, objectives and research questions for the study. These questions in table 6 below, were referred to as direct questions, table 7 shows questions which were left open ended to obtain feedback from the participants.

No	*Usability assessment questions*	*Expected response*
1.	I found this new platform for participation: easy to use and understand.	Agree, neutral, disagree
2.	I found this platform important and interesting	Agree, neutral, disagree
3.	I felt confident that my comments on participation for the first time in the consultative meeting are captured.	Agree, neutral, disagree
4.	I feel confident that my comments on participation will be used in further planning	Agree, neutral, disagree
5.	I understood the way the land uses are mapped on the plan.	Agree, neutral, disagree
6.	I would recommend this application to any other participants.	Agree, neutral, disagree
7.	How would you rate your overall experience with the platform	Highly satisfactory, neutral, highly unsatisfactory

Table 6: Questionnaire for assessing the application

The following questions required making some notes, recommendations or suggestions.

8.	Did you face any interruptions of any kind, stress (technical, user interface, interpretation) factors when using the platform?
9.	Do you think this platform has an impact on the planning process in Uganda and plan preparation?
10.	Do you think this platform is sustainable in the planning processes in Uganda?
11.	Any recommendations or areas you anticipate should be improved in the platform and public participation process in Uganda.

Table 7: Open ended questions for assessing the application

3.8 Rationale of the Methodology

Open source software is mainly used to develop the application because it is readily available and free, it is only downloaded and installed into the computer for application development. There are a number of tutorials that help a new user to easily orientate themselves, the open source community guides new users with queries brought through a forum making it easy for new users with limited experience in developing web applications. The data used for the application and study was readily available from the planning office at Bugembe town council.

The application is based on real time mapping from a web application using an interactive pen and the changes are saved immediately into a database which the planner retrieves at a later stage of the planning process. This will encourage the community to participate in planning decision processes even in the future as they see their opinions reflected directed on the projection. The previous approaches were based on note taking using paper and pen, these notes are subject to getting lost or misinterpretation if transferred to a digital format at a later stage. This method was therefore chosen to enhance confidence among the community that their opinions are mapped and saved immediately, while showing changes made on the screen. This in the long run will not only ease the planner's work but also improve accuracy, data sharing and plan implementation.

We decided to maintain the traditional methods of communal gathering in a central place, other than having the application accessed online, firstly because the community is accustomed to this method, secondly, most locals don't own computers neither internet access in their homes to use the application in their homes like in the developed countries.

The web application was chosen to prove its viability in the developing countries, providing the simplest of methods and interfaces. Most scholars recommend that PPGIS methods should not be changed drastically but gradually, therefore the traditional communal gathering methods were maintained.

The community has a diversity in cultural and religious affiliations which have to be carefully handled otherwise the gist of the application is lost. The educational backgrounds of the expected participants vary in all aspects, the application was designed to fit these diverging interests yet important to achieve the goal of enhancing public participation while at the same time remodelling the neighbourhood.

The methodology chosen aimed at educating the planners about the importance of GIS, as not only a tool for developing neighbourhood plans but also for gathering information generated by the users in the simplest way, saving time and double efforts which the planner could have used in entering the comments from the pen and paper method to the digital format.

The availability of the interactive equipment facilitated the choice of the methodology. The equipment has been used widely in public participation exercises in Portugal, Painho *et al* 2011, we therefore decided to develop a web application and a use the interactive equipment in a different setting in a developing country like Uganda. This will be done to analyse its contribution in promoting public participation in urban planning exercises and assess whether the community in Uganda can easily use the equipment.

4. RESULTS

4.1 WORKSHOP RESULTS

The first workshop held at the town council hall was divided into two sessions, the first session involved the use of the web 2.0 application and the interactive equipment, the second session involved communities mapping land marks in their administrative areas.

4.1.1 Web Application and Interactive Equipment

The interactive equipment involves the sensor, pen and usb for internet connection (Table 8).



Table 8: The wireless sensor, interactive pen and the USB for linkage to internet.

Figure 23: Initialisation of the interactive equipment

Figure 24: Community are sensitised about the interactive equipment and neighbourhood plan

The application was projected onto a wall, attached to the sensor which makes parts of the wall interactive in respect to the projection as shown in figure 23 above, such that, the interactive pen

is sensitive to the projection. The interactive pen therefore acts as a mouse but this time used on the interactive wall.

The neighbourhood plan was presented to the community. The community was in agreement with the plan presented to them, although they had some comments which were not physical and could not be mapped using the interactive application. However they had problems with the boundary which was wrongly captured. They therefore agreed to use the interactive application to adjust their boundaries as shown in figures 25 and 26.

Figure 25: The oldest participant adjusts the boundary

Figure 26: A lady adjusts the boundary

The application was tested by people from all works of life, the old, young, male, female educated and non-educated. The gist of the application was to ensure that every one is involved to make a better analysis of the entire application and realize it´s objectives.

The study was successful and therefore the boundaries were adjusted with the community. The participants agreed to the new boundaries of the town. The changes were retrieved through Quantum GIS with the postgresql database extension. The results of the original and adjusted boundary are shown below in figures 27 and 28 below.

Initial Boundary

Figure 27: Initial boundary before the workshop

Adjusted Boundary

Figure 28: The adjusted boundary using the web 2.0 and interactive screen

A second workshop was held at the Ministry of lands, housing and urban development, this workshop targeted only planners to give comments and analyse the application since they could eventually take on the tool and application for their day to day activities during the public participation process.

Figure 29: Presentation to Planners

Figure 30: Planners make their observations

4.1.2 Community Perceptions of Space

This section of the study was inspired by studies conducted by Carver 2001, when he carried out a SWOT analysis for participation and GIS, he explains that some weaknesses would be addressed through studies on community perceptions of space. In this study, the community

members were therefore requested to engage in a mapping exercise of their neighbourhood to understand the way they perceived spatial features and also to relate their understanding of the land uses mapped on the plan. The exercise was designed to see what came to their minds in reference to a particular area. They were requested to map land uses in relation to their significance to the area or how best the area can be represented.

Essentially this metal mapping was a way of representing how they thought of their administrative areas and how they felt these areas should be represented or what features should not be left out when showing a particular area so that they can easily identify themselves with it at a glance. This work was inspired by Al-Kodmany 2000, he used traditional techniques to enable residents in Chicago to record their opinions and preferences.

This is necessary for Town planning purposes so that the communities easily orientate themselves when plans are put on deposit. This would enable the community to make comments since they can easily relate with the map before them.

In the study, the community agreed upon their boundaries and a base map showing basic information was cut into wards for the administrative boundaries. The community members who represented the different wards sat in groups to map the land marks in their areas as shown in figures 31 and 32.

Figure 31: Participants agree on their boundaries

Figure 32: A group member explains to the other the land marks

The land uses were given rankings and different colours represented different spatial features according to how they were valued as illustrated below. The most significant were shaded red, most important yellow, green was used for important and blue for necessary.

Figure 33: Community perceptions and insert pictures

Figure 33 above shows the areas that the community mapped in the administrative units, thus the wards, the participants painted the landmarks differently according to their significance. Insert are the pictures that show the actual representation of the area on ground from satellite images and insert photographs taken.

Community members drew the area in the way they felt was best representative and very familiar to their real world and how it should appear on maps for them to easily identify with these areas. Community perceptions of space are not highly studied but these representations show how the people value and attribute to their environment. Figure 34 below shows the different land marks and the level of attachment that the participants of each ward had to these land marks.

Features mapped	Wanyama ward	Katende ward	Budhumbuli ward	Nakanyonyi ward
Very significant 	• Major roads • Old buildings	• Round about • Roads • palace	• Railway • Lake Victoria	• Hills • Valleys • Schools
Most important 	• some schools • swamp	• Schools • Market • stadium	• Roads • Health Centre • market	• Roads • cathedral
Important 	• Evening market		• Schools • Religious Centre's	• Planted forest
Necessary  01/14/13	• shops		• Islamic institute	Original residents houses

Figure 34: Community ranking of land marks by ward

In the different wards, we observe that some spatial features receive the same rating across wards, roads were considered as the most significant in wanyama and katende wards, religious aspects were also noticed as a unifying factor, in Budhumbuli the Islamic institute was considered most important while in Nakanyonyi the cathedral was considered most important.

4.2 ANALYSIS OF RESULTS

4.2.1 Descriptive Statistics

The first workshop which lasted for the entire day was enthusiastically attended by 27 participants, well represented by sex, age and professional background, these were people from all walks of life. The second workshop was carried out in the Ministry of Lands, Housing and Urban development to illustrate the application to the planners at the central government organization.(table 9)

Workshop 1	***Sample size***	***Gender***	***Profession***	***Age***	
	27	17 males	4 teachers	***Average***	***35***
		10 females	5 farmers	Minimum	22
			6 business men	Maximum	68
			1 engineer		
			1community development officer		
			2 town planners		
			3 local leaders		
			5 housewives		
Workshop 2	4	4 males	Town planners		

Table 9: Summary data about the participants

4.2.1.1 Age

The workshop was attended mainly by the youth, this group of the population is more engaged in the development processes in their areas as opposed to the old and retired who prefer to get information about the proceedings of the meetings. 81% of the participants were therefore youth, majority male, with only a few participants in the elderly age bracket. The elderly would be expected to participate more because they have experience in how the areas looked like before and the transformations it has under went, therefore they would be in a better position to decide how the future should be portrayed.

4.2.1.2 Profession

The workshop was attended by people from all walks of life, the educated and uneducated, different religious and cultural backgrounds, all attended the consultative meeting to share their opinions about the neighbourhood plan. Most participants were engaged in professional work of some sort, 78% were youth, with limited knowledge in GIS and the use of web applications. This made them a perfect audience for testing the application.

4.2.1.3 Sex

The results show the number of male participants are more than the female participants, 63% and 37% respectively as shown in table 9 above, in many developing countries, decision making processes are attributed to men, Uganda is no exception. It was until recently in the late 20th century that women became recognized as major stakeholders in society who not only play the house wife role but also in the development of their society. Therefore this explains the low representation of women in the consultative workshop, many of the women are uneducated, this makes then feel inferior especially in communal gatherings and decision making processes that involve the men.

Women should be in the best position to participate in the decision making processes for neighbourhood plans, because they spend most time in homes and in the neighbourhoods, therefore are very accustomed to their surroundings than their male counterparts. They know where their children should play, where to go for shopping, the shortest route to most facilities. These are geographical aspects which are significant in the planning process which the women would be in a better position to address.

4.2.2 Usability Assessment

The workshops ended with an evaluation session using questionnaires, responses were collected in relation to questions discussed in tables 6 and 7 above. The community was requested to respond to questions about the application and give their experience with the application. Physical checks were also be done to analyse the usability aspects which could not be captured in the questionnaires.

The quantification of participation levels is complex. Usability evaluation refers to the process of systematically collecting data on how people use the system for a particular tasking a particular environment (Preece 2000, Preece et al. 2007). Scholars have criticized PPGIS studies which have centred mainly around the technological aspects of developing systems and have done very little in regard to the usability assessment. As a result systems have failed to achieve their objectives and to stand the test of time. (Craig et al, 2002. Steinmann et al, 2004).

The usability assessment for the study involved measuring the three core aspects of usability: satisfaction, efficiency and effectiveness. Satisfaction which is defined as, freedom from discomfort, and participants attitudes towards the use of the system. Satisfaction is a response from product use, it incorporates measures of how the system or product was able to please the users. (ISO 1998)

Efficiency refers to the system's ability to full fill the level of effectiveness while taking a certain amount of resources, it is measured by the time needed to perform a specified task on the first attempt.(ISO 1998). Effectiveness refers to the accuracy and completeness with which users can achieve their goals (ISO 1998).

4.2.2.1 Time Spent

The time spent interacting with the application was measured manually by two volunteers. The start time and end time that a participant spent interacting with the application was quantified as shown in table 10 below; the maximum and minimum, represent the ability of the participants to interact with the application. There was no established time for accomplishing a task. As soon as a participant held the interactive pen and started browsing the application, this was considered as the start time till they stopped using the application.

Measurement	***Unit (Minutes)***
Average	10
Median	11
Maximum	20
Minimum	7

Table 10: Summary statistics of the time spent interacting with the application

The participants who spent more time tried to understand the application further before they made any changes on the application. Most of the participants spent time changing the base layers, zooming in and out to find the appropriate scale for easy orientation and familiarisation, to enable them make comments appropriately.

These participants eventually had a better understanding of how the application worked, and were able to help others since they spent more time relating with the interface. Those who spent less time mostly didn't finish the task they had intended to do and gave up in the process while others asked for help and this eventually made them spend longer time.

4.2.2.2 Application Use

The usability assessment is based on the ability of the participants to use the application, this is a measure of effectiveness thus the accuracy and completeness of the task at hand (ISO 1998), as mentioned earlier people from different backgrounds tested the application, the ability of the individuals to easily use the application and relate with it was analysed from the response they gave in the questionnaires besides the physical observations like in figures 35, 36 below and recordings.

In response to the question: 1. ***I found this new platform for participation: easy to use and understand,*** (figure 37), majority of the participants found the application easy to use with only few having difficulties to use the application. During the use of the application, it was noticed that even the elderly were able to use the application without any difficulty as compared to some youth who panicked during the process.

Figure 35: A participant picks an icon to use.

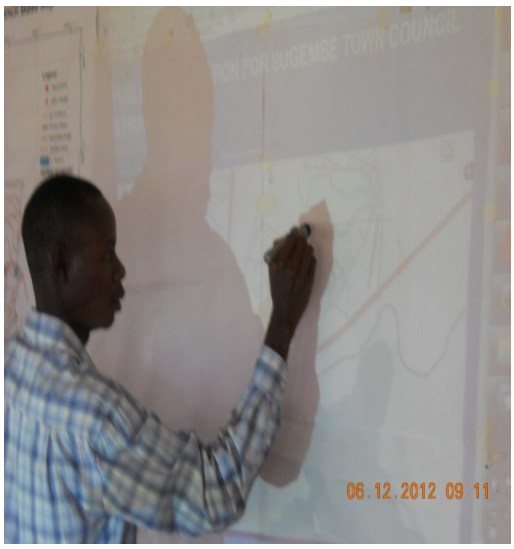

Figure 36: A youth uses the pen to adjust the boundary

Of the 74% who agreed that the platform was easy to use and understand, 51% were youth while 23% were the elderly. This implies that both age brackets found this application easy to use since the meeting was attended mainly by the youth s this explains the higher percentage than the elderly group. Majority of these respondents were male, 66%, found the application easy to use while of those who disagree, 10% were women. There are more females who found difficulties in using the application.

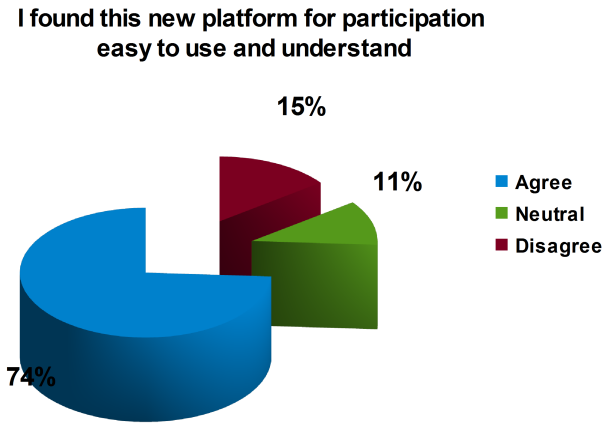

Figure 37: I found the platform easy to use and understand

The participants found it easy to use the interactive pen for drawing but had challenges with the rough surfaces onto which the application was projected and in picking icons for use during the process of making comments. Most of them complained about the icons being very small and close to each, making it difficult to make a choice. Participants wanted to have prior visual

illustrations of how the icons work, so that they would understand which tool can be used for which purpose.

4.2.2.3 Confidence

One of the primary objectives of the application was to ensure that the comments are captured and used in the planning database to motivate the participants as they see their comments captured into the system. This was intended to make the participants gain assurance that their comments would be used to produce the plans in the next stage of the planning process. In response to the question: ***I felt confident that my comments on participation for the first time in the consultative meeting are captured***. And question: ***I feel confident that my comments on participation will be used in further planning.*** (figure 38 and 39) shows that some of the participants are still in doubt that their comments will be considered for planning after the meeting.

The highest percentage of those who felt confident were the youth contributing to 53% and 44% to both questions respectively. In relation to the question: ***I feel confident that my comments on participation will be used in further planning,*** the male participants responded by 48% higher than the response from the females.

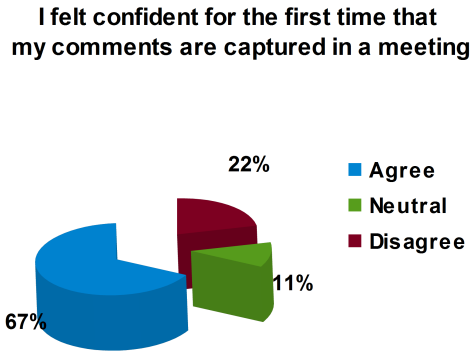

Figure 38: I felt confident that my comments are captured for the first time

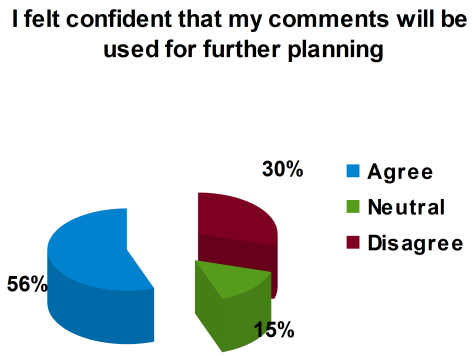

Figure 39: I felt confident that my comments will be used in further planning

The participants who found the application easy to use were also confident that their comments will be used for further planning, most of them saved their changes, while those who did not agree had challenges in using the application, most of them did not accomplish any task, therefore they lost confidence in the application and preferred to have their ideas written down on paper instead.

However some participants wanted to see what will happen or was happening behind the scenes, to confirm that the changes are saved in the plan and not only in the web application. They were

hoping to see the final changes displayed on the final plan immediately and felt uncertain that their changes will be considered.

4.2.2.4 Perceptions

Community perceptions of space were analysed using the question: ***I understood the way the land uses are mapped on the plan.*** This was asked to find out if the representation of spatial features to the community is clearly understood and well interpreted by them even before an explanation is made.

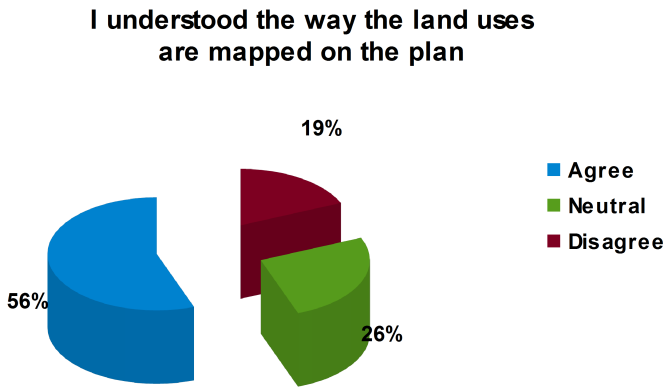

Figure 40: I understood the way the land uses are mapped

More than half of the participants understood the way the land uses were displayed on the maps. This implies that some participants understand the way spatial data is represented while others don't follow how the phenomenon are represented and therefore without an interpreter they would not be able to participate. Of the 55% participants who agreed, 49% were in the youth age bracket while 6% were in the elderly age bracket, there is therefore need to establish mechanisms to have the spatial features represented in the easiest way possible. Most elderly people preferred to have displays of land uses with less colour variations as most of them had visual impairment.

According to the professions, those who had knowledge on geographical features, easily understood the land uses contributing to 35% of the 55% response. They couldn't for example mistake a contour for a road, while others couldn't easily differentiate features that were similar and hence couldn't relate these to real world picture of the area they live in.

The female participants responded highly to this question by 29%, they easily understood their neighbourhoods and orientated themselves much easily than the male participants. Women spend more time around the neighbourhood and are more observant of any slight changes as compared to the men; they are more involved in neighbourhood activities, they know the nearest route to

the market, to their children's day care, which neighbours are close to their households among others.

It was noted that the participants often preferred to have a base map switched on in the background for them to understand the land uses in the neighbourhood plan, the base map acted as a guide to show the real situation on ground presenting features that they are familiar with in everyday life. Most of the participants preferred to have google maps base map as compared to the open street map which showed only the streets leaving out features they could easily identify with.

4.2.2.5 Satisfaction

Satisfaction is a standard measure of usability assessment to ascertain the ability of participants to attain their goal within the required period of time, with no or minimum discomfort. From the studies, figure 41 below shows 74% felt very satisfied with the application, this means that they understood how the application works, used it and obtained results as required. The non satisfied minority faced challenges when making comments using the application, therefore they expressed their dissatisfaction.

Some participants felt dissatisfied when some base layers took so long to change to the one that they desired to have. Others failed to continue using the application since they could not easily orientate them selves once the desired base layer failed to load.

The number of participants who felt satisfied with the application where the same who found the application easy to use, both questions were represented by a percentage of 74, responding to agreed for question: ***I found this new platform for participation: easy to use and understand*** and satisfied to question: ***how would you rate your overall experience with the platform.***

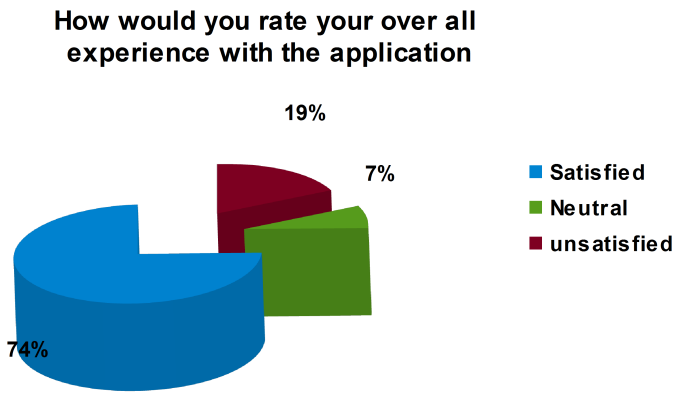

Figure 41: Over all rating of application use

However in relation to satisfaction, the percentage of those who disagree increased as compared to the question: ***I found this new platform for participation: easy to use and understand.*** This

implies that many participants moved from being neutral in the, easy to use and understand to unsatisfied in the satisfaction level question.

These participants were mainly those who faced interruptions and discomfort, this was found out when the open questions were evaluated.

4.2.2.6 Recommend the Application

To ascertain the importance of the application in the planning process in Uganda, the question: ***I would recommend this application to any other participant*** was asked. This was related to the question about the overall experience with the application.

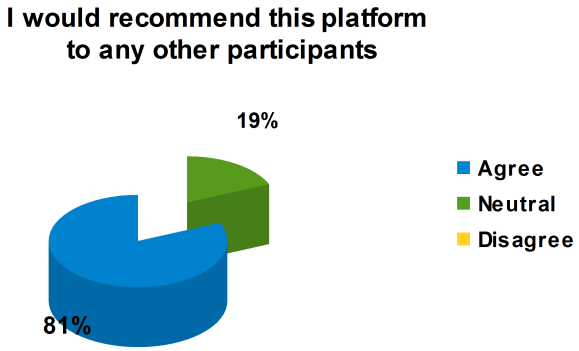

Figure 42: I would recommend the application

Of the 81%, 43% were in the youth age bracket while 38% were in the elderly age bracket, therefore the old and the youth have a high representation of the question related to recommending the application. The female were less in this category having only 32% unlike their male counterparts.

The participants who agreed that they would recommend the application where those who responded positively to the question: ***I found this new platform for participation: easy to use and understand*** and those who felt satisfied by the application. However the trend is higher than in the two questions with 81% unlike the other two questions with a representation of 74% of the participants.

4.2.2.7 Open Questions

The responses from the indirect questions were treated mainly as recommendations from the community members and the planners at the ministry of lands, housing and urban development. The responses provide an understanding of the participants experience and areas that should be improved.

	Question	*Some Responses*
7.	Did you face any interruptions of any kind, stress (technical, user interface, interpretation) factors when using the platform?	- Felt nervous in the beginning - Scared to make mistakes - Some icons were small
8.	Do you think this platform has an impact on the planning process in Uganda and plan preparation?	- It will help ease the planners work - improve data update - no, may not be affordable
9.	Do you think this platform is sustainable in the planning processes in Uganda?	- No, for fear of no electricity - No, since its internet based
10.	Any recommendations or areas you anticipate should be improved in the platform and public participation process in Uganda.	- demonstration for icons - 3d representation - Have insert pictures as pop ups - key board for comments - measures for attribute data - Cater for community estimations in terms of scale - Distance measurement tools

Table 11: Responses to open ended questions

4.2.2.8 Interactive Equipment Use

Although the application evaluation workshop went very well and tremendous results were obtained for the application, there were some short comings during the workshop. Some participants found a lot of difficulty in using the application and were always helped by those who felt confident to use the application,'chauffeurs'(Haklay and Tobón, 2002) as shown in figure 43 below. Others kept referring to features that they needed to change by hand, they often forgot to use the interactive pen to make the adjustments in the plan, as shown in figure 44 below.

Figure 43: A participant is helped to pick an icon..

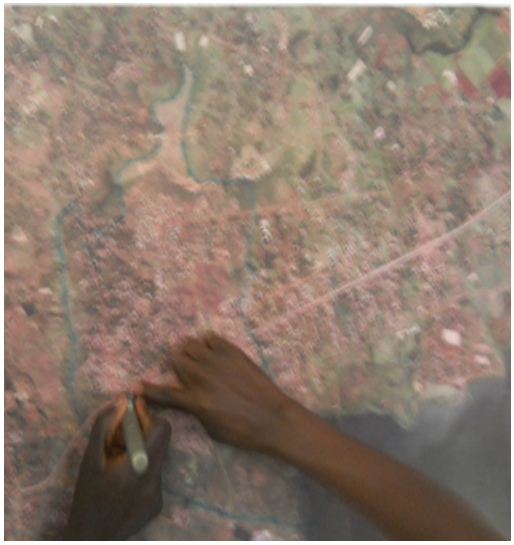

Figure 44: Some participants forgot to use the interactive pen and referred to changes with their fingers.

The wireless sensor was unable to stick to some surfaces, figure 45, a participant held it for the entire exercise which was exhausting. There where also surfaces which were rough and the pen wouldn't work well on them like the wall on the figure 46.

Figure 45: Usability assessment: equipment perspective

Figure 46: Some surfaces were rough to be made interactive

5. DISCUSSION

The studies support the hypothesis of interactive screens have an influence in enhancing participation levels in Uganda basing on the levels of participants' interaction with the application. The study objectives were achieved and the study was conducted successfully. This section involves two categories, the discussion about the web application and the interactive equipment and the other is about the community perceptions of space.

5.1 WEB APPLICATION AND INTERACTIVE EQUIPMENT.

This section is divided into there components: critical assessment of design elements, technical use or experience with the application and the levels of engagement to measure participation levels.

5.1.1 Critical Assessment of the Design Elements

The design for the interface was very simple with basic icons for use in the application. The participants made the best use of the application to attain the desired study. Useful observations were made during the process. However the icons on the interface were very small and too basic for consideration as compared to other public participation applications like the studies for the London profiler, Hudson-smith *et al* 2007. There was need to have an automated timing system connected to the application to measure amicably the time a user spends on the application, how they spend the time and on what specific function.

The design provided for the use of base maps as a guide for orientation, this was a positive consideration. However this functionality was lost when most participants decided to explore more in changing the base layers instead which at times took very long to load. The open street maps were very basic and did not give the participants good guides for orientation. Google maps which relates to exactly what is on ground should have been used alone as it was the most preferred.

5.1.2 Technical Use and Experience

The participants found it easier to use the interactive pen since all they needed to do was press it against the wall and move it as required, just like they would have used a ball pen on paper. However, majority of the participants faced challenges with the surface onto which the application was projected, most participants complained that they would not easily pick an icon unless they tried several times. Some had challenges with using the GIS applications on the platform such as zoom, pan and editing. They suggested to have in future a demonstration of how each icon works in form of a video along side the application. This implies that if they are left to have such an application online without guidance then they will not easily make any comments,

the process should therefore be gradual and simple interfaces should be continuously used until time 'T' when such a community can be exposed to online applications and contribute from their homes.

The participants expressed their concern on how to undo a particular task performed especially after saving the changes. They suggested to have an icon that enabled one to undo the changes after saving since most of them were new to the application. It was difficult to redo the intended task once a slight mistake was made and saved. Those who realised the mistake before saving the changes only had to refresh the page while those who saved and later realised some parts of the mapping where wrong had to do it all over again.

5.1.3 The Levels of Participation and Engagement

There was an established relationship with the time spent, application use (effectiveness) and over all satisfaction. The participants who spent more time analysed the whole application making it easy for them to effectively complete the required task and hence felt satisfied with the application. This finding is in line with the study carried out by Meng and Malczewski 2010, about usability and system effectiveness. In their results the effectiveness of the system had a strong influence on the users duration on the website, in relation to satisfaction, they commend the use of modified features, less icons, making the task obvious so that users can easily complete the task at hand. However in the open questions, from this study, users requested to have more icons instead to explore more on the application for better understanding, therefore it is important to establish how many icons to use to enhance the satisfaction levels in web browsing.

However there was no trend in this specific example in relation to either female or male, profession or age differences in the effectiveness and satisfaction. It was difficult to clearly mark the trend across the different measures of usability.

It was noted that the female participants had a better understanding of the area than the male, they easily orientated themselves on the web applications although they felt timid in most cases when asked to use the interactive pen to draw what they described. They preferred to give verbal explanations than having their hands on the application. This relates to their educational background, social and cultural position in society as secondary to men. This is consistent with studies carried out by Kyem, 1999, in promoting local community participation in forest management in Ghana, he discovers that some women in the society were not willing to freely express their opinions due to their cultural and religious beliefs, they had to be silent in community meetings or first seek permission from their husbands.

The male youth on the other hand found it easy to use the application, majority understood what had to be done and in most cases guided the elderly on using the application, although some

elders managed to use the application freely as compared to some youth but these were only the minority. Most elderly participants had problems with the display due to sight problems they felt the colours where too many and contrasting to identify a particular land use.

In the responses received from open questions, the recommendations, show that the participants have a general understanding of GIS and maps. Participants suggested to have the representation of the features in 3D, insert pictures for orientation, measurement tools, key boards for attribute data, among others. This shows that they are willing to adjust to new technological interfaces for better understanding of their areas and perhaps this will improve their participation levels in future. This relates to studies carried out by Al-Kodmany 2000, in three Chicago neighbourhoods using a combination of GIS tools to enhance visualisation. Although the planners seem to still maintain the ground that the interfaces should remain simple but emphasis should be made on the scale estimates by the community.

The number of participants was very small for a public participation meeting in relation to the population in the neighbourhood. The majority of the participants are elites, this explains why it was easier for them to use the application. This is not a good representation of the population for analysing the effectiveness of the application. Although Kingston and Smith, 2007, talk about the lower the scale, local in this case, the higher the population interested. In this study the situation was different and inconsistent to their idea, as more participants were expected than received since the activity was based at the local stage. Ugandans have a tendency to attach more importance to issues that are said to have come from the central government or at the national level than locally generated issues. However the publicity and the invitation process to attend the meeting could also have led to the low turn up rate. Future research should be based on a good representation of the entire population in the town council for similar studies.

During the mapping process, while some participants hesitated to make changes before others for fear of embarrassment in case they couldn't use the interactive pen, others felt confident to use the application and consulted in case they dragged the pen wrongly and needed to make changes. This showed that some participants need a more detached environment where they can make their comments freely without feeling watched by the other participants.

The participants were always willing to help each other in the use of the application, those who had 'mastered' the icons and how to use them reached out to help those who felt stranded. The willingness to help each other creates a feeling and ability to use an online application in future, they would easily network, interact with each other and discuss amicably planning concerns before them.

One workshop was held to measure the hypothesis for the study, whether interactive screens influence the levels of public participation in Uganda, this is not enough to draw ample

conclusions for the application and the study. This was done due to the short available time for the research to be conducted and for evaluation of the application. In addition the research is based on academic purposes, planners and other policy makers should be able to manage such applications with the most minimum programming experience so that the application is continuously used.

Generally the community used the application with much ease than expected to attain the meeting objectives and adjusted the planning area boundary as required. The results of the adjustment were shown on the web application and the members were in agreement with the changes. The participants who used the application enjoyed using it, it was noted that most of the participants preferred to have the displays in a relatively large scale so that they could easily view what was displayed before them yet the projection couldn't facilitate for this large scale viewing.

5.2 COMMUNITY PERCEPTIONS OF SPACE

Our study enabled us realise that communities have pertinent representations that they easily relate with. The design process was very simple, the traditional methods of using pen and paper, were maintained which most people were accustomed to. It was easy for them to sketch their neighbourhood by themselves without the involvement of an 'artist' as seen in other participation studies. Therefore their ideas were not influenced by what some one preferred or felt was the idea land mark. This relates to Al-kodmany's argument on traditional methods instilling confidence in the lay people.

The cut out maps had basic information about the area, to help them get oriented and add onto what was presented before them. This was a good functionality for the study, however the scale representations tended to vary between what was shown on the map and what the communities opted to show. The participants preferred to have their landmarks in relatively large, to show the clear picture of the area. The drawings that they made tended to over lap the guide that was presented on the maps. This implies that communities prefer to have the land uses mapped in relatively small scales showing big pictures for them to easily orient themselves. This could have implications on huge GIS databases, future research should ensure that community scale representations are catered for while considering the space conditions in the database.

In town planning, roads play an important role of orientation, often times people need to know where the road is passing as a starting point to understand the display and its from that they can easily make their comments for planning purposes. Planners often times show only the major roads in an area yet the community is interested in even the smallest footpath that they use to make a short cut to the nearest market or the nearest house. Such features are important for their understanding of the spatial features.

Planning processes in Uganda, only show a coloured plan with different colours referring to different land use types. From this study it was realized that communities need to see the actual

features on ground, for their easy orientation, they need to see the proposals over laid or superimposed on the existing land use so that they can easily understand the area in reference and therefore easily make their comments about the proposals in the neighbourhood plan.

People prefer to identify features that they come across in their day to day lives or activities that they engage in on a daily basis. The significance of spatial features was based on cultural and religious affiliations, in areas where they had strong attachment to cultural aspects they raised these as the most significant feature while in areas where the majority were Christians they identified mainly with these religious facilities like wise in areas that were dominated by Moslem.

In some wards they looked at old buildings as a major guide for orientation. Such community ideas provide the planners with a guide on information that they should show on neighbourhood plans and how important such features are, the old buildings perhaps should not dealt away with to preserve the cultural heritage but measures of regeneration should be established so that these land marks are maintained yet still making the city aesthetic.

The participants tended to map land marks in relation to ownership of land, they referred to a specific feature in relation to how close to, next to or with in. These are important measures of location for spatial referencing purposes. Secondly the fact that they tended to attach ownership of the land versus the feature they represented showed how much the tenure means to them. In Uganda land is owned based on different systems of tenure, generally land is either owned by an individual, government, institutions or communally. It is therefore important that land marks are represented in relation to which type of tenure or land ownership.

The women still had a greater influence in the mapping process, they understood their neighbourhoods very well and guided the men in most cases helping them get the spatial picture of what they referred to. They participated more in drawing the land marks on paper. This relates to studies carried in South Africa Mpumalanga (Weiner and Harris 2007), where the men and women were divided in groups to map their ideal land reform and from their drawings, the women had more representation of the area and gave more details as compared to the men.

6. CONCLUSIONS

6.1 Summary of Results and Application

Public participation GIS research shows there is tremendous improvement in the way people, space and environment are represented while analysing their social implications.

These studies are carried out as experiments to ascertain the best approach for a given community, 'if you need to know if a shoe fits, you ask the one wearing it and not the one who made the shoes,' it is no doubt the studies that involve real world scenarios understand the society's position in GIS. There is no better or best approach so far, since communities change from time to time and so do the needs and the technological applications available. To keep up the pace is one thing but to ensure that the approaches used enhance participation is the other.

The study was carried out to assess the applicability of web application using interactive equipment in a developing country like Uganda, the approach was different from the rest used in Uganda; a country which has experienced several periods of war, and lost many generations over the years, technological advancement was therefore affected. The technology advancement in Uganda is still at its early stages, in relation to PPGIS for web applications, not many people own computers in the country let alone have internet connections. The approach used sought to work with in the means and to use the traditional methods of GIS, that involved participants gathering in a central place, combined with the web 2.0 application.

Most developing countries have resorted to only traditional GIS methods without realizing the potential in using low technology, technology in PPGIS studies is not an end to the means but understanding the community and the scale at which they should be involved is more compelling. Traditional methods although have their short comings, they are still good approaches to PPGIS but a touch of high technological applications is even better to help communities transcend from a stagnant and boring approach to more innovative and exciting application.

This study involved the use of a web application with an interactive pen for communities to make comments on a neighbourhood plan. The web application was not designed as a take home application but a work through jointly with all community members in a central place where all participants gathered.

The meeting in Uganda provided a platform that was well represented community members to discuss planning issues that directly affected their environment. Although the workshop for evaluation was only conducted once in a particular area, with a small representation of the population, the meeting produced interesting results with the community easily understanding and using the application. The community mapped their own comments without the 'artist' or planner doing it for them. The interactive pen not only excited the participants but also they found it easy to use. The application was easy to use for people from all walks of life, the old,

young, were all able to use it for making their comments, it was just like drawing their boundaries but this time round drawing it on a web application on a wall.

These adjustments were well saved into the data base; the planner upon return to office was able to retrieve the changes and adjusted them in the final plan for documentation purposes saving the planner's time that would be spent on re-entering the data, making adjustments and assumptions from the verbal communications from the community members. This also improved the accuracy levels in the data captured which would have been compromised if the planner had written down the changes in ink on a paper.

The second session of the workshop involved mapping land uses in the area, this was done to understand the participants perceptions of space. The community made the planner realize that it was necessary to show physical features during the plan deposit process, they represented how they perceived their neighbourhoods. From these representations we realized it was easier if they had a base map of the existing situation in the background of the proposals made so that they can easily identify with the areas and make comments during participatory meetings. Land ownership or tenure plays a significant role for communities to identify what is close to whom (person, institution, public) and to which land use.

6.2 Challenges

Although the studies were successful, some challenges were faced during the process: some participants thought the process had political intentions, they were afraid to participate in the beginning of the meeting for fear of being quoted during the process. When they realized that the other participants were not afraid to share the views they then opened up and used the application for planning for their neighbourhood.

The application is internet based, during the workshops the internet connections were on and off and in some cases very slow. This is why some participants had problems with some layers taking long to load, this affected their participation as some of them eventually gave up.

6.3 Future Works

These is need to consider studies on scale and location estimates of the communities, most community members preferred to have displays on large scales and in the community mapping exercise. The case study was rather simple based on fuzzy ideologies, but if in future we need more complex and intensive mapping of points, line and polygons, actual positions, then there is need to take care of the location estimates of the communities.

The planners suggested that attribute data be incorporated during the process of using the application. They added that if there is need to make proposals in terms of points, lines and polygons then these proposals would to be saved into the database showing what they exactly represent for example if a school and health centre are represented as polygons, the attribute data

should also show these details so that the planners work is eased, when he\she retrieves the data from the database. They also suggested that there should be a key board for entering some of these details in the application.

The planning process in Uganda requires for plan deposits for a period of 3 months for structure physical development plans[9] and 6 weeks for detailed plans, this is done to ensure that the entire community has access to the plans and makes comments since during the plan presentations the whole community can not be in the same place and at the same time. The application used for the study needs a 'chauffeur' who continuously gives the community guidance on the application, this may not be feasible in the Ugandan situation. Future research should therefore establish ways in which the application can be left for display without having a chauffeur considering the social and cultural variations of the society.

To enhance the participation levels further, the application could be based on use of mobile phones, according to Marsden 2009, in his study about what the developed world can learn from the developing countries, he asserts that most people in Africa own mobile phones with camera functionalities which can be put to the best use. The community would still have the neighbourhood plan displayed onto a screen in a public location, the comments would be sent by way of pictures, specifying an area of the plan they like and dislike. This would also help to understand the geographic location of those participants who are more active and how the less active can be influenced.

In conclusion the study was successful and produced great results. The research questions used for the study, to analyse if interactive screens enhance public participation in Uganda, produced true results from the analysis that was made from the output of the workshops. Although one workshop was not enough for measuring the hypothesis of the study. If the recommendations from the community are incorporated in the application, the application will produce enormous results and enhance public participation in the field of not only planning but other public participation applications.

9 The planning process involves preparation of plans at different stages, the structure plan is the starting point, its mainly broad guidelines and the detailed plans are derived from the structure plan, which give more detail as the name suggests.

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ANNEXES

Questionnaire

The questionnaire is used for assessing the web 2.0 platform using an interactive screen for public participation in Uganda.
The ideas expressed will be used exclusively for study purposes; the application is part of the study project to attain Masters in Geospatial Technologies. Kindly answer all the questions to the best of your knowledge to enable the researcher achieve the study objectives. In case of further inquiries contact: +256772982463. Thank you very much for your time and suggestions.

Project: Web 2.0 using interactive screens for public participation in urban planning in Bugembe town council
User group: Workshop participant
Interview number: 1
(Interviewee: Mr. X)
Age:
Gender:
Occupation/profession:
Interviewer: Pamella Drate
Date: 25.11.2012

Fill in the spaces as deemed necessary and place an X mark, where boxes apply, to indicate your choice

1. I found this new platform for participation: easy to use and understand.

☐ Agree ☐ Neutral ☐ disagree

2. I found this platform important and interesting

☐ Agree ☐ Neutral ☐ disagree

3. I felt confident that my comments on participation for the first time in the consultative meeting are captured.

☐ Agree ☐ Neutral ☐ disagree

4. I feel confident that my comments on participation will be used in further planning process

☐ Agree ☐ Neutral ☐ Disagree

5. I understood the way the land uses are mapped on the plan.

☐ Agree ☐ Neutral ☐ Disagree

(Comment if any)

……
…

6. I didn't face any interruptions of any kind, stress (technical, user interface, interpretation) factors when using the platform.

☐ Agree ☐ Neutral ☐ Disagree

(Comment if any)

……
…

7. I think this platform has an impact on the planning process in Uganda and plan preparation.

☐ Agree ☐ Neutral ☐ Disagree

(Comment if any)

……
…

8. I think this platform is sustainable in the planning processes in Uganda.

☐ Agree ☐ Neutral ☐ Disagree

(comment if any)

.....
.....

9.I would recommend this application to any other participants.

☐ Agree ☐ Neutral ☐ Disagree

10. How would you rate your overall experience with the platform

□ **S**atisfied

□ Neutral

□ Unsatisfied

11. Any recommendations or areas you anticipate should be improved in the platform and public participation process in Uganda.

……

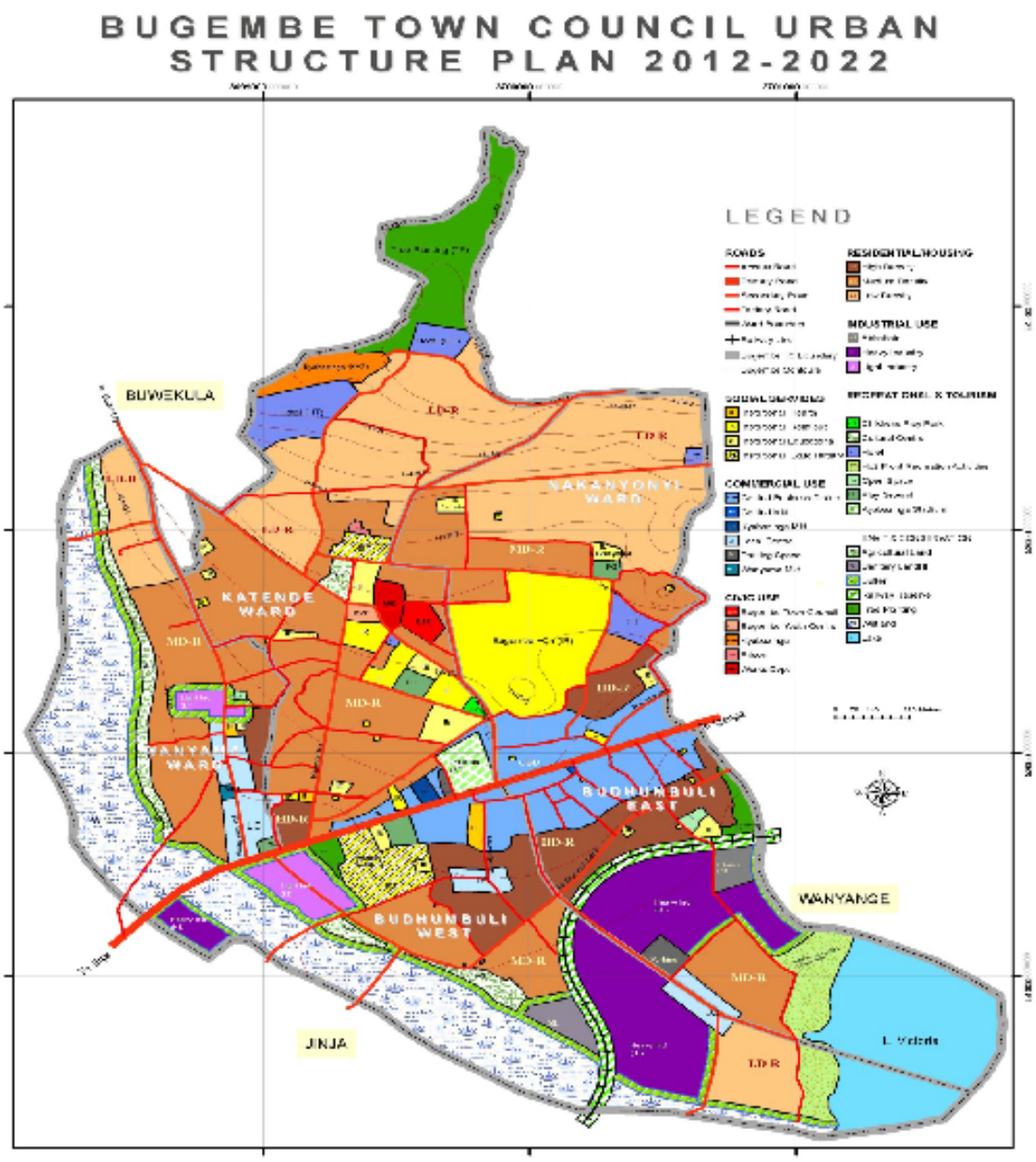
Responses to Open Questions

	Question	*Responses*
7.	Did you face any interruptions of any kind, stress (technical, user interface, interpretation) factors when using the platform?	- Felt nervous in the beginning - Scared to make mistakes - the maps take long to come on - The pen was not easy to drag on the wall - Some icons were small to see and use
8.	Do you think this platform has an impact on the planning process in Uganda and plan preparation?	- I don't think it will be easy to use in Uganda - With the cultures and attitudes of the people, it is difficult - It will help ease the planners work - It will improve on the data capturing in the plan generation - no, may not be affordable and easy to maintain - May not be applicable if left to community without proper guidance
9.	Do you think this platform is sustainable in the planning processes in Uganda?	- No, since I did not understand the illustrations - With continuous sensitization, it can be sustained. - The planning process in Uganda involves several periods for plan presentation to communities, it is not possible to employee some to continuous show the community how the tools work. - Some people are afraid to use such tools and technology - No, for fear of no electricity in some remote areas - No, since its internet based and many local councils cannot have internet access.
10.	Any recommendations or areas you anticipate should be improved in the platform and public participation process in Uganda.	- Create more icons - have an elaborate demonstration for icons or tools to use - 3d representation would give a better

	understanding - Have insert pictures of the area for pop ups - Add a key board for comments - Incorporate measures for attribute data - Cater for community estimations in terms of scale - Distance measurement tools - improve on the speed at which the application works. - Sensitisation of every stakeholder is needed to ensure that every body understands how to operate the tools - Introduce more local names in the maps to ensure that the whole area is understood - Use less flashing light and less colours for better visualisation.

Shapefile Transformation

Bugembe Structure Plan



Thesis Work Plan

Tasks	OCT 2012		NOV 2012		DEC 2012		JAN 2013		FEB 2013		MAR 2013
Phase 1	1–15	16- 30	1-15	16-30	1-15	16-30	1-15	16-30	1-15	16-30	
Write Introduction and Literature review											
Phase 2											
Organization of required data											
System design and user interfaces											
Linking and integration of spatial plans											
Writing methodology											
Phase 3											
System testing											
Usability assessment											
Phase 4											
Result analysis and conclusions											
Final report and presentations											

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