ASSESSING THE IMPACT OF 3D VISUALIZATION AND E-PARTICIPATION ON PUBLIC PARTICIPATION IN PLANNING PROCESSES IN KISUMU CITY, KENYA.

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Enschede, The Netherlands. February 2017

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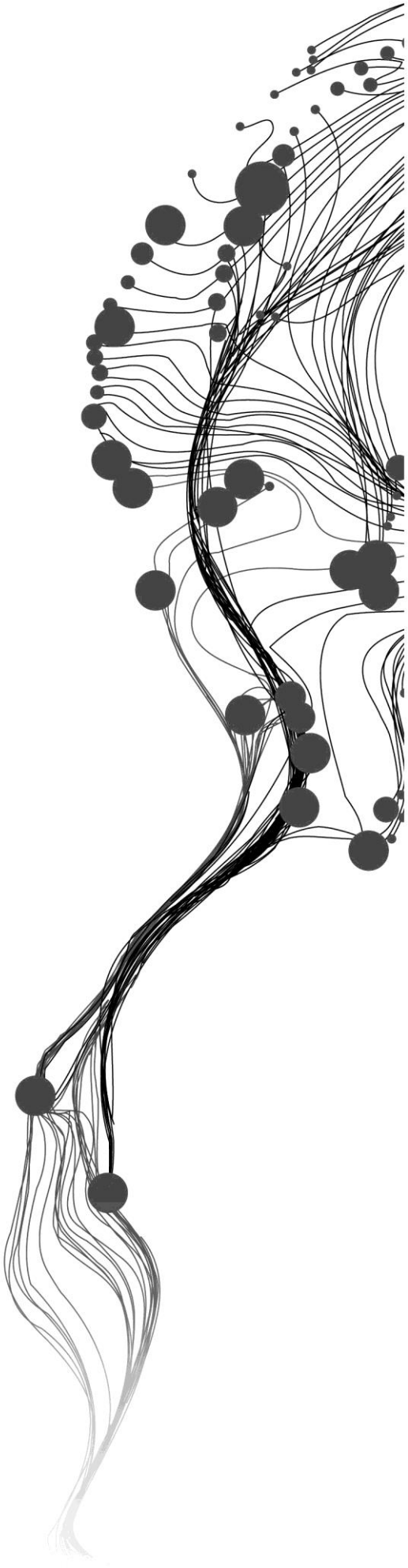

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ABSTRACT

The advocacy for the involvement of citizens in spatial planning and decision making processes that directly or indirectly affect them has gained momentum globally in the recent past. While most governments are continually putting effort in policy and practise to guarantee public participation in planning, research has shown that most of the participation processes do not yield much in content or quality of the decisions coming from them. Existing gaps and weaknesses of the current methods of inviting and carrying out public participation include non-explicit legislations, stakeholder apathy, inaccessible media, lack of transparency and accountability among others.

This study sought to assess if the integration of 3D visualization and E-participation can have impact on public participation. Rule Based Modelling was used in CityEngine 2016 to create a 3D city model transposed into a web-geoportal and used as a Planning Support System (PSS). The PSS was used in a controlled experimental study comparing 2D against 3D representation. There is no explicit framework for assessing impacts. However, this study used five impact indicators namely; Efficiency, Effectiveness, Satisfaction, Learning and Communication.

The study revealed that the newspaper adverts and community leaders frequently used to invite public participation have serious shortcomings. The 2D paper maps commonly used during public participation workshops are sometimes hard to interpret especially for non-technical participants. Vernacular radio stations formed the most preferred channel of invitation while Short Message Service (SMS)/Unstructured Supplementary Service Data (USSD) (95%), online forums (78%) and email (60%) were the most preferred modes of participation. From the study, effectiveness and efficiency varies within different groups and with the 2D and 3D representations. Results showed that 83% of respondents preferred 3D over 2D representation while 81% indicated that what they learnt from the 3D presentations made them change their thoughts. 3D representations were therefore preferred by majority of the participants in the study workshops.

The study concludes that there are more opportunities offered by the integration of 3D web-geoportals with E-communication capabilities. However, careful consideration must be made on the indicators to be used to assess impacts. Different case studies should be used before conclusions are made. This study recommends the development of stand-alone 3D web portals and a review of policies and legislation on public participation to be more explicit.

Keywords: Public Participation, 3D modelling, 3D visualization, PSS, E-participation, Impacts Indicators.

Dedication

Mary Msagha, Onyimbi Nandi, Auma Hawi, Abura Nyokeno, Auma Nyonyimbi and Ragot Nyayoki, this is for you!

For where grass has grown, grass will always grow!

ACKNOWLEDGEMENT

The Trinity of trinities who is limited not by space, time or matter, God the Father, whose steadfast love and grace has brought me this far, to Him Glory and Honour. You granted me peace that surpasses all human understanding even in all trials and low moments. Every time I wanted to quit, and those times were countlessly many, I thought about the very young nephews and nieces looking up to me as a model. The incessant monologue within myself on what I would tell my kids (the great Onyimbi Nandi Jnr and Hawi the Princess of Owila) if I quit kept me on toes to deliver my best and never say die. Young as you may have been, the thought of you kept me going through. My wife's support was insurmountable. May God reward you Nyar Taita, for you took the responsibility and pain of taking care of the family with your head high up. Never give up is the word that came from my grandmother, Ragot Nyayoki, as she offered a prayer every single day, reminding me of the tiger-spirit of her daughter, my late mum Auma Nyachianda.

To my brother Ken, thanks for standing by me. Sisters Patty, Naomi and Abura, thank you so much for showing me nothing is impossible until you let it be. This life ain't worth without you! To the staff that kept Octopub Investment Ltd running, accept my gratitude.

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Aluta Continua. For where grass has grown, grass will always grow!

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LIST OF ABBREVIATIONS AND ACRONYMS

2D	2 Dimensional
3D	3 Dimensional
3DIBM	3 Dimensional Image Based Modelling
AOI	Area of Interest
CAD	Computer Aided Design
CBD	Central Business District
CBO	Community Based Organization
CGA	Computer Generated Architecture
CGK	County Government of Kisumu
DEM	Digital Elevation Model
DTM	Digital Terrain Model
EAC	East African Community
FGD	Focused Group Discussion
GIS	Geographic Information Systems
GML	Geographic Mark-up Language
GPS	Global Positioning System
IBM	Image Based Modelling
ISO	International Standards Organization
KNBS	Kenya National Bureau of Statistics
LA	Local Authority
LASDAP	Local Authority Service Delivery Action Plan
LATF	Local Authority Transfer Fund
LoD	Level of Detail
NGO	Non-Governmental Organization
OSM	Open Street Map
PGIS	Participatory Geographic Information Systems
PSS	Planning Support System
RBM	Rule Based Modelling
SDSS	Spatial Decision Support System
SEDAC	Socioeconomic Data and Applications Centre.
USSD	Unstructured Supplementary Service Data
VR	Virtual Reality

1. INTRODUCTION AND JUSTIFICATION

1.1. Introduction.

The use of 3D visualisation and E-participation methods are becoming increasingly popular in urban planning and management in the developed and developing world. This is supported by continued technological innovations in computer vision and internet communication witnessed in the past few years. These methods offer great opportunities in facilitating efficient and effective public participation and bridging possible gaps in the traditional top-down methods of planning. 3D visualization facilitates the development of different perspectives of reality through inclusive interaction of stakeholders. E-participation on the other hand creates independence of space and time where stakeholders can choose how, when and where to participate in the process. This allows for the contribution of different stakeholders irrespective of their geographical location or time of day. This section, divided into background, research problem, objectives and questions, discusses the need to study 3D visualization and E-participation, with emphasis on Kisumu City.

1.2. Background and justification

Public participation is about the ways and methods in which citizens exercise influence on and control over the processes and decisions that affect them or their surrounding environment. The principle of public participation (in some cases referred to as citizen participation) in planning has grown considerably over the past two decades. It however gained momentum after the Rio Declaration of 1992. Principle 10 (part III) states; *"States shall facilitate and encourage public awareness and participation by making information widely available. Effective access to judicial and administrative proceedings, including redress and remedy, shall be provided* (UNEP, 1992)." Thereafter, many states started adopting participation in their planning processes (Milosz, van Lammeren, & Hoogerwerf, 2007).

This growth was based on the notion that traditional planning methods were more technical, only done by experts on behalf of the government (Dambruch & Krämer, 2014). As a result, citizens were left as recipients of plans they neither participated in developing nor understood. Albretchs' further asserts that *'In most traditional spatial planning, the focus is clearly on producing a plan, and public involvement is mainly end-of-the-line'* (Albrechts, 2006 p. 1153). Even if they were to be involved, most members of the public are usually not planning experts, neither do they have the technical knowledge to understand the detailed plan presentations.

With increasing urbanization, scholars have argued that traditional methods are unable to adjust to the growing complexity and multiplicity of sustainable urban management (Dambruch & Krämer, 2014). Moreover, most plan preparation and implementation have been left haphazardly to anyone who has influence at the cities, municipalities or planning bodies thus compromising quality (Ngau, 2013).

The benefits of broad-based community involvement and participation in planning processes are widely documented. Al-Kodmany (1999) contend that it enhances the capacity of citizens to cultivate a stronger sense of commitment and ownership, increases community satisfaction, helps in identifying and/or creating realistic planning issues, expectations of outcomes, and building trust. Secondly, using local knowledge, citizens are able to define and represent scenarios differently and can feed specific knowledge about their situation into the planning process. This can improve the quality and realism of the information contained in the plans (Wu, He, & Gong, 2010). Al-Kodmany (1999) and Knapp, Bogdanh, and Coors (2007) further argue that community involvement and participation has the promise of good design because it improves communication and cooperation, meets the requirements of actors, fulfils their lifestyles, and carries the essence of their desires and expectations.

Visualization of geographic phenomena has been in practice for over a thousand years. In his books on visualization (1997,1990,1983) as quoted by Al-Kodmany (2002), Edward Tufte described and illustrated universal design concepts for visualizing numbers, nouns, motions, processes, explanations, and narratives. Various authors (Arciniegas, Janssen, & Rietveld, 2013; Bilge, Hehl-Lange, & Lange, 2014; Hayek, 2011; Neuenschwander, Wissen Hayek, & Gret-Regamey, 2014; Wanarat & Nuanwan, 2013) have argued that visualization presents a common channel to communicate information to all stakeholders, both technical and non-technical. This improves understanding and helps in building consensus during the planning process (Knapp et al., 2007). Visualisation offers a method for seeing the unseen through the conversion of abstract data into concrete visual representations (Simão, Densham, & (Muki) Haklay, 2009).

Advancements in computer and information technology, especially Computer Aided Design (CAD), Image Based Modelling (IBM) and Geographic Information System (GIS) have revolutionized the visualisation of 3D architecture, plans, maps and scenes. Today the use of data from various acquisition technologies such as active (LiDAR) or passive (image-based) sensors (Koeva, 2016), CADs, smart phone applications and Unstructured Supplementary Service Data (USSD) for mobile phones has gained steady momentum. This revolution has resulted in further development of better 3D visualisation tools and techniques that support public participation in planning processes, commonly referred to as Spatial or Planning (Decision) Support Systems (SDSS, PSS or PDSS) (Arciniegas et al., 2013; Barton, Plume, & Parolin, 2005; Simão et al., 2009). According to Simão et al. (2009), SDSS are explicitly designed to help decision-makers navigate through complex and semi-structured spatial problems through the acquisition and management of spatial data; the representation of geographical objects and their spatial relations; the performance of spatial analysis; and the creation of map-based outputs.

The presentation of 3D geo-data in web-based geo-portals present greater potential for interactive information exchange and communication amongst stakeholders. The web offers three opportunities; the contents can be user generated, the interoperability of information and the inclusion of the social context of the user. A widely used alternative especially in situations where public engagement is sought, Simão et al. (2009) observe, is to create a website (or geo-portal) where the 3D information (maps, plans,

alternatives) is published and participants submit their comments and concerns by email or by filling-in forms on the website. For example, Kingston et al. (2000), as quoted by Simão et al., (2009), describe a system– Virtual Slaithwaite, which was used for planning a village in Yorkshire. One feature of Virtual Slaithwaite was that *"comments were attached to specific map features, such as buildings, open spaces, rivers or canals, instead of the centroid of a grid cell."* (Simão et al., 2009 p.2029). A website offers the advantage of independence of space and time, where participants can avoid special visits to public facilities to submit their comments, and can submit the comments any time of the day other than official office hours.

The concept of E-participation borders on and borrows heavily from E-governance, the complete transformation of the processes of governance using the implementation of Information & Communication Technology (Potnis, 2010; Saxena, 2005). E-governance aims at bringing faster and transparent service delivery, accountability, information sharing and people participation in the decision making and governance processes. This transforms not only the way in which most public services are delivered, but also the fundamental relationship between government and citizens (Linders, Liao, & Wang, 2014; S. Paul, 2007). It promotes greater accessibility, capability to obtain government services without visiting their offices, and reduced service costs (Saxena, 2005) through online provision of government information which would otherwise be difficult to obtain or unavailable. According to Dawes (2008), the five objectives of E-governance include formulating policy frameworks for legitimizing the foundations for E-governance, enhanced public service approach replacing organizational-centred approaches with customer-centred initiatives, cost-effective but high quality government operations, administrative and institutional reforms emphasising on transparency, accountability and trust, and citizen engagement in democratic processes, often referred to as E-participation.

E-governance has three primary delivery models (Hafkin, 2009). Implementing governments can adopt any or all of the three for its services. The three models include;

- *Government-to- Citizen (G2C) — Governments providing the citizens with details of public sector activities, increasing the input of citizens into public sector decisions and improving public services delivered to members of the public, in terms of quality, transparency, accessibility and cost. Examples in Africa include the Rwanda Online Government Services and the Mauritius Government Online Centre.*

- *Government-to-Business (G2B) —Entails services exchange between government and the business community. These may include downloading application forms for licenses, renewals, payment of taxes and e-procurement. One example is the Contribution Network Project Mauritius.*

- *Government-to-Government (G2G) — this involves the synchronization of public administration processes by leveraging on technology for better service delivery. Decentralization of government and the connection of local to central government is one way to achieve this, for example in the Woreda Net project of the government of Ethiopia.*[1]

[1] *Adopted from Hafkin, 2009.*

E-governance has registered successes in countries where it has been applied. Taiwan's E-government "one window" service integration and the advancement of ubiquitous access through a range of channels (from computers to cell phones) has "…provided a robust platform for improving government administrative efficiencies, service quality, and national competitiveness, while contributing to the consolidation of Taiwan's democracy" (Linders et al., 2014 p 2). Other projects that have registered significant milestones in the implementation of comprehensive and increasingly mature E-government portals include the USA's (USA.gov) business-like model which gives information efficiently without asking for opinions (no E-Participation), the United Kingdom's (Gov.Uk) where citizen participation is very much encouraged and Singapore's award-winning E-Citizen Portal (Linders et al., 2014). In developing nations, the practice is picking up, but the successes are yet to be documented. The Asian region has Singapore, Japan, Korea and India as leaders in implementing E-governance (Evans & Yen, 2006). In India for example, different cities, like Delhi have adopted E-governance in registration of driving licenses, providing information on government tenders and registration of cooperative societies (S. Paul, 2007). Delhi's model is more like the USA business-type, with little or no E-participation. In Africa, South Africa, Mauritius, Egypt, Seychelles and Rwanda have taken a lead in implementing E-governance (Hafkin, 2009). Since 2013, the Kenyan government embarked in the development of an e-portal, christened *e-citizen* (https://www.ecitizen.go.ke). The successes and failures of this are yet to be studied since it's fairly new and still under improvement. Nevertheless, it provides access to different government departments and services. In the USA in particular, some states have adopted policies that open government deliberations to public view and modest interaction, including back and forth communication by legislators via e-mail, websites, blogs, newsfeeds, broadcasts and webcasts. Research has also looked at the contributions of computer-mediated planning tools such as UrbanSim (a simulation tool for participatory urban planning) and their results for encouraging public participation or managing and using public input in government decision making (Linders et al., 2014).

According to Hafkin (2009), more emphasis has been put on the G2C model, since it strives to improve citizen involvement in decision making. Therefore, many E-governance initiatives aim at developing and improving E-participation where citizens can participate in decision processes irrespective of time of day and location. The goal of such initiatives should be to provide a channel through which information can be disseminated or exchanged, views expressed or registered and feedback collected (Evans & Yen, 2006; Hudson-Smith, Evans, & Batty, 2005; Linders et al., 2014; S. Paul, 2007) in a more accessible but transparent and accountable manner (Hafkin, 2009; Hudson-Smith et al., 2005; Linders et al., 2014).

3D models can be visualized in 3D web-based geoportals and used as planning support (PS) systems or tools for spatial planning. The development of such a web-based geoportal with interactive capabilities enhances e-participation, especially if it can be accessed easily using desktop computers, tablets or even phones. Interaction can be increased by providing open online forums, comments sections, feedback sections, email exchange or mobile phone application message exchange. Barton, Plume, & Parolin, (2005 p 634) opine that 3D visualization and E-participation (remote participation through web based forums and phone applications) promote the development of different perspectives of reality through inclusive

interaction of stakeholders by identifying goals, insights, interest and starting points in the planning process.

In spite of the global diffusion of E-governance initiatives, getting its claimed benefits has faced various technological and organisational challenges. Governments and regions are unique in their conditions, needs, obstacles and challenges. Corruption, poor infrastructure, unequal access to technology, poverty and low literacy levels may curtail the full implementation of E-governance. According to Saxena, the implementation of E-governance initiatives sometimes suffer from 'the common drawback of treating it as a techno-centric project and loosing track of the 'governance' (or excellence) focus' (Saxena, 2005 p. 11) . In the same breadth, most of the initiatives focus on one-way communications rather than interactive discussion or deliberation. This makes it hard for any contributor to be certain if their contributions reached the intended entities or not. This may in turn discourage participation or contribution, confirming the assertion by Saxena (2005) that citizen engagement receives much less attention in practice than services or management concerns.

1.3. Research Problem

Spatial planning typically involves multiple stakeholders. Different stakeholders often bring different levels of knowledge and input about the components of the planning problem, make assumptions and reflections based on individual experiences. This specific knowledge and experiences can be used to ensure realism and enrich the plan content. At the same time, stakeholders, more specifically the general public, need to learn about the likely outcomes of their stated preferences. With enhanced access to information, increased public participation in decision-making and support for distributed collaboration amongst planners, stakeholders and the public, this learning process becomes faster and easier (Wanarat & Nuanwan, 2013).

In Kenya, planning is still more of the traditional top-down approach, with minimal or no public involvement or participation at different stages of the planning process. With 47 counties and 4 major cities, all differing in context, planning practice in Kenya is similar across the country. Local development plans are usually initiated by the governments (local, county or national) depending on the geographic scope of the plan. Thereafter, 'influential' stakeholders (Ngau, 2013; Okello, Beevers, Douven, & Leentvaar, 2012) are called for a stakeholder's meeting where these plans are presented. These include senior government officials, politicians, politically-friendly NGOs, civil groups, vocal opinion leaders and the business community. In most cases, these meetings appear more like plan-briefings and only for record-purposes and do not yield much in terms of content addition to the plans. The end user, the public citizen, on the other hand remains at the tail-end of the process: - unaware of the whole process and only receive final plans for comments or do not see the plans at all.

Kisumu is not any different. In most cases the public is never involved at the initial stages of plan conceptualization and preparation, but only at the presentation of the draft or final plans. These presentation meetings have sometimes suffered from stakeholder apathy, with reported cases of boycotts or lack of attendance. However, the responsible governments usually proceed with the implementation of

the plans. A case in point was the preparation of Lower Nyakach Regional Development Plan 2006[2], in which three consecutive stakeholder meetings were boycotted, with residents quoting lack of involvement during preparation of the plans.

In development control for example, the by-laws of Kisumu and the Physical Planning Act 1996 require that a developer must place an on-site advertisement and a newspaper advert in any one of the local daily newspapers. If the approving authority does not receive any written objections within fourteen days, the developer is allowed to develop his/her parcel. The same applies to any local or county development plans proposed by the authorities.

From the observations made, the current practice does not promote or enhance public participation. The medium used to invite public participation (daily newspapers, notices placed in public offices and on-site adverts) are not accessible to most members of the public. Even if they did access newspapers, the advertisements are usually too small and indistinctly placed in the newspapers making them too hard to notice. Most public office notice boards are not accessed by members of the public at all times.

Recent experiences have demonstrated that citizen participation is potentially useful to the provision of basic services and the management of local public goods and common property resources, the democratic process and local empowerment. Citizen participation and engagement help citizens to reconcile their multiple interests and explore trade-offs (United Nations, 2012). In spite of these, it is still hard for practitioners to explicitly define the stage of the planning process at which citizens can be engaged. More so, striking a balance between improving the number of participants and improving the quality of the input has been a challenge to most practitioners. However, there is a general agreement amongst practitioners of the need not only for more but also effective participation. "Effective participation" is that which helps ensure efficiency and economic growth on the one hand, and equity and social justice on the other. It is suffice to say that effective participation is condition and situation dependent, and always a hard thing to achieve.

Despite Kenya government's focus on improving public participation to incorporate local knowledge and solutions into the urban and community planning processes, most planning processes in Kisumu have not paid attention to the possibilities that 3D visualisation and E-participation may offer in improving the quality and quantity of public participation. Understanding the existing gaps in the current planning practice is essential in determining the extent to which 3D visualization and E-participation may offer possible solutions to bridging the existing gaps. Globally, a lot of research has focused more on E-governance in general. Little attention has been paid to E-participation, a component of E-governance. These form the basis of this research, looking into the impact of using 3D visualization in public participation as compared to the traditional 2D maps and the opportunities offered by E-participation against existing practices of inviting public participation.

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2 Author participated in the process as part of Maseno University bachelor's degree planning studio, 2006.

1.4. Research Objectives.

This research is guided by an overall objective. To ensure systematic and structured process, research questions were used to achieve the stated specific objectives.

The main objective of this study is to investigate the impact of 3D visualization and E-participation on public participation and collaboration in local development plan preparation and control. The following specific objectives guided the study.

1. To explore the existing methods for inviting public participation.
2. To establish the levels of public participation achieved by the existing methods.
3. To create a 3D model of Kisumu, present in a geo-portal with communication and interactive capabilities and test it as a Planning Support Tool.
4. To assess the impact of 3D visualization and E-participation on public participation.

1.5. Research Questions

The following research questions were answered to achieve the specific objectives.

Research questions for objective 1. To explore the existing methods for inviting public participation.

- ✓ How does the county government invite and engage the public in local development plan preparation and development control processes?
- ✓ At what stage of the planning process are the members of the public involved?

Research questions for objective 2. To establish the levels of public participation achieved by the existing methods.

- ✓ In the identified area, has there been a government initiated local plan?
- ✓ Was there public participation and how?
- ✓ In general, what factors influence public participation?

Research questions for objective 3. To create a 3D model of Kisumu, present in a geo-portal with communication and interactive capabilities and test it as a Planning Support Tool.

- ✓ What type of data is required to create, visualize and export 3D City model into a geoportal?
- ✓ What type of indicators can be used to test impacts of the PS tool?
- ✓ What activities or tasks can be implemented to test the indicators?

Research questions for objective 4. To assess the impact of 3D visualization and E-participation on public participation.

- ✓ What is the impact of 3D visualization of scenarios on public participation in spatial planning processes in Kisumu?
- ✓ What is the impact of E-participation on the quality and quantity of public participation in spatial planning processes in Kisumu?

1.6. Conceptual Framework

The Key factors studied in this research are people, the planning system in place, public participation and technology and their influence on effective public participation. The framework is divided into yey factors, factor components, impact indicators and their variables as summarized in Figure 1. The first component involves the interaction between people (experts, government-local or national and citizens) and the existing planning legislations. The way in which information is disseminated to and/or exchanged between different players is more often guided by the existing legislation. Such legislation also define the conduct of planning professionals and the rights and responsibilities of citizens in as far as public participation is concerned. This interaction results in certain planning practices and behaviour which, over time, form a country or city's planning culture. The second component is the use of technology for design, visualization and communication of planning tools, decisions and/or processes and how such technology can influence participation in general. Impact Indicators were used in this study to realise the objectives while the variables were used to operationalize the indicators to answer the research questions.

People and planning systems: Planning is all about the people and the system that define the patterns of interaction among them. Traditionally, the design of planning processes has always been left in the hands of experts acting on behalf of the government (Grant, 2003). Planning brings in different experts from different government departments including health, environment, infrastructure development and spatial planning itself. Other players include experts from these domains in private practise acting voluntarily or on contractual assignments from the government.

On the other hand, all planning interventions are in many cases directed at offering possible solutions to a societal problem. The general public (citizens) are the consumers of these interventions. It is therefore imperative that they are involved in making decisions that directly or indirectly impact their daily lives (Grant, 2003; Onyach-Olaa, 2003). This can be done passively or actively (Okello et al., 2012; Walker, Sinclair, & Spaling, 2014) through public gatherings, formal gazette notices, E-contribution among others.

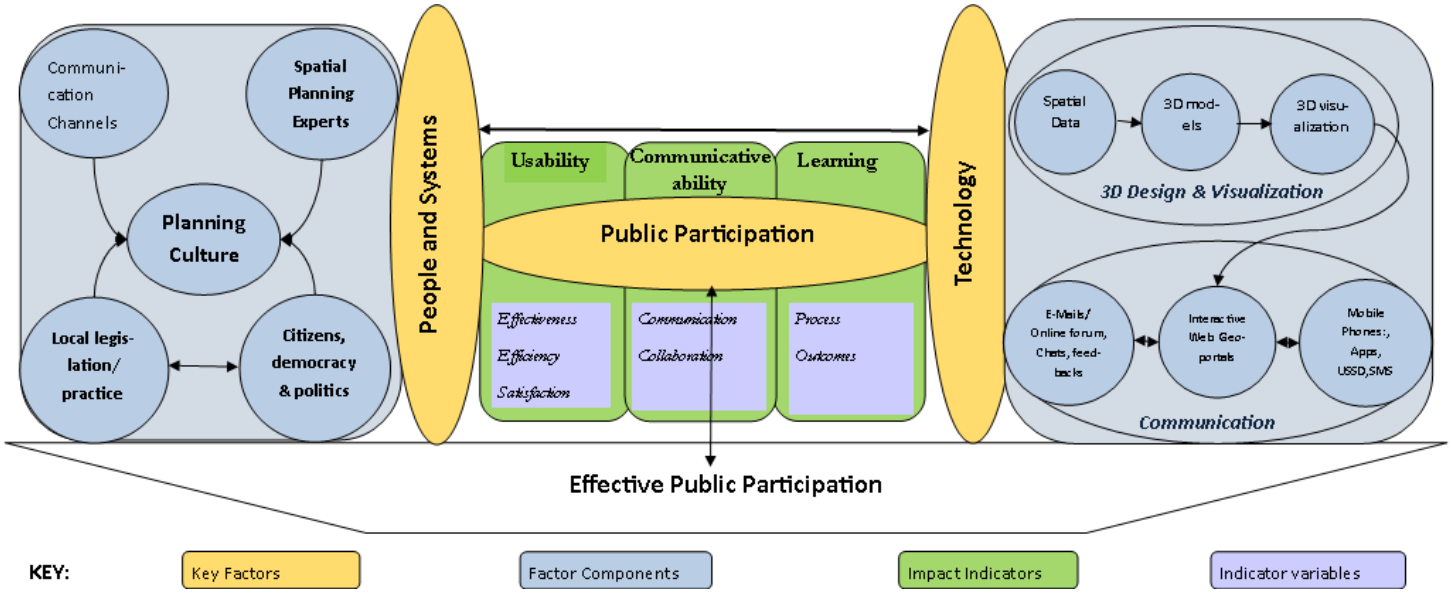

Figure 1: The conceptual framework

In many government structures, Kenya for example, spatial planning is governed by Acts of parliament and such other legislation as City Bylaws. Such legislation defines the roles and responsibilities of different players and the communication media through which planning information may be disseminated. Local authorities play a central role in spatial planning processes. First, they are the custodians of all spatial development plans within their jurisdictions. Secondly, local authorities are in most cases the originators of spatial development plans, or act as implementing agencies for national government development plans (Okello et al., 2012). More so, they are the fulcrum through which the government communicates its planning policies and decisions to the public and coordinate different government departments' involvement in planning.

The approaches and practises by the different experts and stakeholders, the inter-governmental relations in planning and citizens exercising their democratic rights in decision making define particular patterns and practise of planning. The communication media to a great extent influence the type and nature of participation thereby influencing the quality and quantity of public input into the process. The legislative frameworks and the planning practice over time exhibit particular patterns of planning. These interactions form the planning culture of a nation or city. The development of any tool that aims to improve public participation should provide a forum for which all the different stakeholder can interact and exchange views in a free and transparent manner. However, in most cases, this is not possible due to institutional, technological or political challenges as will be discussed in subsequent chapters.

Technology: Technological advancements have provided opportunities to manipulate and manage spatial data. It has also helped in devising newer ways of inviting and engaging different stakeholders in planning processes. The advent of Computer Aided Design (CAD), Image Based Modelling (IBM), Rule Based Modelling (RBM) and the worldwide web (www) has provided functionalities for visualising, managing and manipulating spatially referenced data (Pullar, 1997) while at the same time offering seamless

dissemination of various planning products to stakeholders (Pouliot et al., 2016; Simão et al., 2009). Creation of 3D models from spatial data has been made easier and faster by different software. Visualizing the models in 3D web-based portals can enable integrated interaction through emails, online fora, mobile phone SMS, USSD or smart applications.

Impact Indicators: In his work, te Brömmelstroet (2015) portend that testing if and how any Planning Support System (PSS) can improve planning processes is essential in developing rigorous and detailed technological rules for the application of the PSS. For planning research to successfully generate usable mechanisms in evaluating the impacts of a PSS, indicator-testing research designs are needed with sufficient measurable indicators (Pelzer & Geertman, 2014). The indicators used for this study aimed at evaluating user perspectives in usability (effectiveness, efficiency & satisfaction), Communication ability (communication and collaboration) and learning (learning process and outcomes). The concept of learning is often used to specify digitally supported communication processes (Pelzer, Geertman, Heijden, & Rouwette, 2014; Pelzer, Geertman, & van der Heijden, 2016).

Effective public participation can be achieved only if such processes guarantee fairness and equity for all stakeholders. As such, any PS tool and legislations in place must strive to encourage transparent two-way information exchange and sharing. Proper utilization of modern technology and legislative and normative readjustments to present planning needs has the potential of significantly transforming the process from just public participation (focused on quantity) to a more proactive effective public participation (centred on both quality and quantity). However, the idea of what is a good, successful or effective public participation process depends both on whose perspective is being considered (governments or citizens') and what that perspective entails.

1.7. Limitations

This study is area-specific. Due to other factors, the level of participation may differ per area or neighbourhood. This study is thus a general representation of planning in Kisumu in general. The socio-economic, spatial and political characteristics also differ by neighbourhood. The time for the study and data did not allow for the coverage of the whole city in this research. Due to insufficient knowledge and skills in programming and web development, cloud hosting services provided by ArcGIS online was used instead of creating a standalone geo-portal.

1.8. Research Matrix

Table 1 show a summary of how each objective was achieved; the type of data required, the software and tools used for acquisition and analysis of data and the results that were anticipated at the end of the study.

Table 1: A matrix of Objective, how they will be achieved and what will be used to achieve them.

Objectives 1: To explore the existing methods for inviting public participation.				
Questions	***Data requirements***	***Tools/Software requirements***	***Collection and Analysis***	***Anticipated results***
How does the county government invite and engage the public in local development plan preparation and development control processes? At what stage of the planning process are the members of the public involved?	Secondary: (Literature review, Local planning practice knowledge) Primary (Planning practice & Culture, Socio-economic data)	Literature review articles Voice/video recorders. ArcGIS 10.4 SPSS Excel	Qualitative & Qualitative (Literature review, Key Informant interview, local Knowledge, Questionnaires)	List of methods of inviting public participation Statistical analysis of identified factors (weighted).
Objective 2: To establish the levels of public participation achieved by the existing methods.				
In the identified area, has there been a government initiated local plan? Was there public participation and how? In general, what factors influence public participation?	Primary data (numbers)	Voice recorder, Notebooks. SPSS	Survey and Interviews Use of social media (twitter and whatsapp groups to dispatch questionnaires)	Indicator scores graph to determine public participation level. Qualitative analysis on handling responses.
Objective 3 & 4: To create a 3D model of Kisumu and present in a geo-portal with communication and interactive capabilities and test it as a PSS & Assess the impact of 3D visualization and E-participation on public participation.				
What type of data is required to create, visualize and export 3D City model into a geoportal? What type of indicators can be used to test impacts of the PS tool? What activities or tasks can be implemented to test the indicators? What is the impact of 3D visualization of scenarios on public participation in spatial planning processes in Kisumu? What is the impact of E-participation on the quality and quantity of public participation in spatial planning processes in Kisumu	Building footprints & heights, utility shapefiles, Parcel boundaries, Primary data (perception)	Erdas, ArcGIS, ArcScene, City Engine, SPSS,	Digitization, IBM, RBM, classification, 3D modelling & Visualization Surveys and interviews	3D model & geo-portal, 2D representation, Comparative analysis

1.9. Conclusion.

This research presents a good opportunity of looking into the relevance of leveraging on modern technological developments to develop on existing methods and techniques of spatial planning. Particular interest is in the acceptable use of technology to present planning scenarios in clear but easily understandable format to different stakeholders, promoting equity in access and utilization of public information for public good. Kisumu city forms a good study point since no studies on the integration of both 3D visualization and E-participation into the planning process has been carried out before. Similarly, it presents a suitable study area due to its spatial development prospects and it's recent adoption of E-services through the government of Kenya's e-citizen portal.

2. LITERATURE REVIEW: TECHNOLOGICAL ENHANCEMENTS FOR PUBLIC PARTICIPATION IN SPATIAL PLANNING.

2.1. Introduction

This chapter details the definitions and scope of public participation, its evolution, and role in spatial planning. It also highlights how technological developments, especially in design and communication, have transformed the way in which different actors, state and non-state, engage the public in decision making processes. The chapter introduces public participation in a global scale and contextualizes it down to current practice and legislative requirements and provisions in Kenya. Different technological developments are explored, particularly the advent of 3D modelling and visualization and the application of web and smart technologies to improve communication.

2.2. Definition and Evolution of Public Participation.

Planning in this whole study refers to spatial planning, that is, "the complex processes of regulating land use that (often) ends with a decision as to where (not) to place what" (Holgersen, 2013 p 6). Public participation, according to Enserink, Connor, & Croal (2006), is defined as the involvement of individuals and groups that are positively or negatively affected by a proposed intervention (e.g. a project, a program, a plan, a policy) subject to a decision-making process or are interested in it.

Public participation in spatial planning has received significant advocacy both from scholars and politicians as a result of its current mainstream position in the development sector. Apart from the statutory requirements of some nations, there are continuing debates about why governments and planning institutions should involve the public in their processes. Proponents of public participation base their arguments on normative theories of democracy and collective action (Sexton, 2013) or on substantive and instrumental justifications related to improving quality, enhancing legitimacy, and building capacity (Holgersen, 2013; Walker et al., 2014). Some academics relate the development of public participation to a convergence of new legislative requirements, growing citizen activism, and changing professional values (Peng, 2001).

Over the last decade, a host of terminologies have emerged to describe citizen involvement in influencing processes that affect them. These include governance through communities (Rose 2000), decentralization of governance (Fischer 2000), Third way (Giddens 1998) all as quoted by Lane (2005). Other Practitioners use new quasi-legislative and quasi-judicial governance terms, including deliberative democracy, e-democracy, participatory budgeting, public conversations, citizen participation, public participation, collaborative policy making (Hayek, 2011; Knapp et al., 2007). However, the central focus of all these

terminologies is the need to involve citizens, civil and social groups, NGOs, business community and other stakeholders in various planning processes and decision making.

Research and practice in public participation has been propelled by academic scholars who have engaged not only in studying ways of conducting public participation but also looking at its relevance and usefulness (Grant, 2003; Guaraldo Choguill, 1996) to planning processes. According to Sexton (2013), public participation aims to achieve one or more of these six main objectives:

i) Improve the quality of decision output.

ii) Represent values and preferences in proportion to their prevalence in the affected population

iii) Encourage competition of arguments with respect to criteria of truth, normative validity, and truthfulness

iv) Use common sense as the final arbiter in disputes

v) Empower less privileged groups and individuals, and

vi) Demonstrate the variability, plurality, and legitimacy of dissent.

The role of public participation is largely determined by the nature of the planning tasks to be undertaken. The extent to which participation may be offered to the public depends largely on the planning problem at hand, the knowledge required for that problem and the decision making context.

While different authors agree that public participation is essential for good governance and empowering local citizens (Bingham, Nabatchi, & O'Leary, 2005; Enserink et al., 2006; Grant, 2003; IFAD, 2009; Sexton, 2013), various critics have faulted the prospects of public participation in advancing good governance. For example, Sexton (2013) opine that 'the desirability of public involvement and the design of appropriate participation processes are value judgments that reflect the political power of certain stakeholders to influence those choices'. Similarly, planning agencies still have the discretion in determining who to involve in planning decision making, at what stage they are involved, the type and intensity of involvement, the influence of public participation on the final decision, and the goals of the whole participation process (Albrechts, 2006; Grant, 2003; Ness, Urbel-Piirsalu, Anderberg, & Olsson, 2007; Ngau, 2013; Onyach-Olaa, 2003; Sexton, 2013). This exposes the whole processes to the risk of abuse by influential stakeholders, killing the very spirit of transparency and accountability. Moreso, the methods used by the agencies in carrying out public participation in most cases leave citizens with no 'real' influence in the processes, especially if the discretionary power is held by the authority or influential stakeholders.

2.3. Levels of public participation.

In her work[3], Arnstein (1969) created a typology of eight levels of participation. Each rung in the ladder (illustrated in Figure 2) corresponds to the extent of citizens' power in influencing the process and the end product.

The bottom part of the ladder (rungs 1 & 2) describe levels of "non-participation", where the real objective is not to enable people to participate in planning, but for power-holders to "educate" or "cure" the participants. It is usually used by the power-holders to substitute genuine participation (Arnstein, 1969; Guaraldo Choguill, 1996). In levels 3 and 4, citizens voices may be heard, but they do not have the guarantee that their voices will be heeded by the 'influential' stakeholders. The higher up the ladder, the increase in the degree of citizen power in influencing decision making (Guaraldo Choguill, 1996).

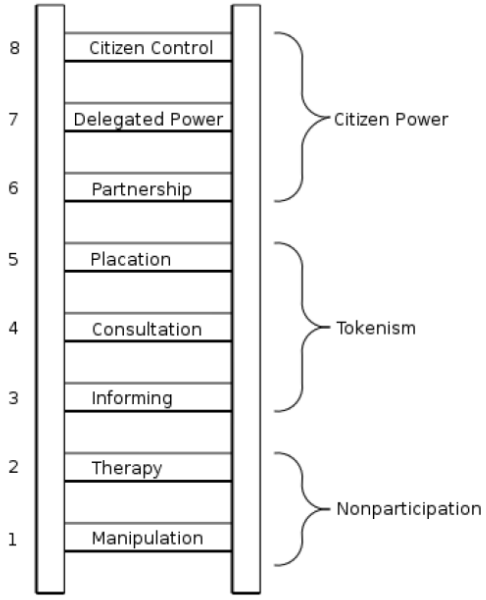

Figure 2: 8 Rungs on the ladder of citizen participation (Arnstein, 1969).

In Rung 5, the ground rules allow the have-nots to advise, but the power-holders retain the right to decide. In rung 6, citizens can enter into a partnership with the power-holders, enabling them to negotiate and engage in trade-offs. Delegated Power and Citizen Control where the have-not citizens have the majority of decision-making voices is not easy to achieve even in advanced democracies.

Although this ladder presents a good typology of citizen participation, it suffers major drawbacks. For example, in reality, neither the have-nots nor the power holders are homogeneous blocs. Each group has divergent points of view, significant cleavages, competing vested interests, and splintered subgroups (Arnstein, 1969; Guaraldo Choguill, 1996). Secondly, the typology does not heed cognisance to the roadblocks that hamper structural realization of citizen power. These include racism, paternalism, and resistance to power redistribution from the power holders on the one hand, and poor political and socioeconomic infrastructure, inadequate, knowledge-base, alienation, and distrust from the have-nots on

[3] *Ladder of Citizen Participation 1969.*

the other (Arnstein, 1969). Wells, Ward, Feinberg, & Alexander (2008) observed that this ladder offer a more general classification and does not account for serious leadership challenges of engaging and retaining those divergent constituents.

2.4. Merits and demerits of public participation in planning.

Public participation has increasingly become a way to involve citizens in community planning and decision making owing to new legislative requirements, increased citizen activism changing institutional and professional values. The impacts of public participation on spatial planning may be far and wide, but they depend on which side of the divide one is viewing them from. The sponsors (government, planning agencies etc.) have different interests and goals in one divide while the consumers (citizens, civil society, business community, special interest groups etc.) in the other divide have their specific goals and interests. There are many claims about the positive and adverse impacts of public participation in spatial planning. In assessing the impacts of public participation, two questions arise. The first question is whether the processes that are more participatory yield better results in quality, capacity and legitimacy or not. The second question is the presence of trade-offs where the success of one criteria compromises the success of another (National Research Council, 2008b). These questions can be answered by looking at the potential outcomes of public participation as opposed to the processes itself. The bulk of this outcome-oriented empirical research has focused on assessing the impacts of public participation processes on a range of citizen participant attributes. According to the National Research Council (2008), these studies have consistently demonstrated increased levels of interest in and knowledge of public issues, improved capacity for future public involvement, increased propensity for social bond formation and improved trust of fellow citizens.

An experimental survey of 378 individuals by Arvai (2003) about public participation in the deployment of nuclear generator in space exploration shows that when people believe that a decision resulted from a public participation process, they are more likely to accept the decision (National Research Council, 2008a). Carpini, Cook, & Jacobs (2004) presented a number of studies carried out by Fishkin, which found out positive outcomes on how participation changed people's opinions on the issues raised and that people who engaged in deliberative polls were more likely to vote afterward. Participation enabled participants gain factual information about the issue at hand, as well as more general political knowledge.

Jelagat & Barasa (2013) observed that public participation helps the public to avoid the imposition of priorities from outside. This is because public participation allows the involvement by local populations in the creation, content and conduct of the programmes or policies aimed at changing their lives. It also allows the recognition and utilization of local capacities and resources (Jelagat & Barasa, 2013; Sieber, 2007). Hansen & Prosperi (2005) on the other hand concluded that use of interactive internet based participation can improve the democratic foundation for the decisions taken by involving the citizens more actively in the decision-making process.

Many studies have reported numerous benefits and impacts of public participation in planning processes. However, there seems to be a convergence of the benefits and impacts of public participation from different studies, as summarised by (Carpini et al., 2004; Pelzer et al., 2014, 2016; Peng, 2001).

- Citizens become more engaged and active in civic affairs (Carpini et al., 2004; Peng, 2001).
- Citizen tolerance for opposing viewpoints increases (Carpini et al., 2004; Peng, 2001).
- Citizens' understanding and ability to justify their preferences improves (Carpini et al., 2004).
- Faith in the democratic process is enhanced (Carpini et al., 2004).
- Legitimacy of government will increase as people have a say in and better understand its workings (Carpini et al., 2004).
- Improves genuine communication between planners, decision makers and citizens (Pelzer et al., 2014; Peng, 2001).
- Promotes the inclusion of ideas and insights from various disciplines (Pelzer et al., 2014).

Some studies have also recorded negative impacts of public participation. Carpini et al., (2004) enlists studies of efforts to increase citizen involvement carried out in 5 US cities in the year 2000 by Mendelberg and Oleske. The study revealed a failure to increase participation rates. Other studies have reported feelings of dissatisfaction and frustration among participants (National Research Council, 2008b; Okello et al., 2012). Various scholars therefore agree that achieving effective and efficient public participation and evaluating its impacts is complex, context-dependent and does not guarantee the success of the process itself, citizens' satisfaction or planning agency's responsiveness to the needs of the citizens.

2.5. Public Participation in Kenya

In the post-independence Kenya, most planning and decision making was a preserve of the central government. In the 70s, the government de-concentrated its administration system to the local authorities (LA) to exercise control at the expense of locally elected leaders (Grant, 2003). In this structure, the government, national and local, designed and implemented planning policies with no consideration of the citizens' views or public participation.

After the Rio declaration of 1992, the Kenyan government started the process of engaging in public participation through different ways. One key way was the transfer of 5% of national income to the LAs, christened Local Authority Transfer Fund (LATF). Part of the LATF conditions had been that; a). LAs had to prepare a Local Authority Service Delivery Action Plan (LASDAP) through a process of citizen participation (Grant, 2003; Okello et al., 2012) and b). LAs had to publicly display information on the resources available for service delivery (Grant, 2003). This was meant to build confidence in the public to demand for accountability from the LAs. However, most planning decisions taken through public participation were never implemented either because of lack of funds or diversion due to political interests. The public confidence in participatory processes declined as a result. Planning decisions then

became ad hoc and left in the control of a few powerful officials;- town clerks/treasurers or politicians;- Mayors/Chairmen (Grant, 2003; Ngau, 2013).

This period also experienced an upsurge in the number of civil society organizations, Non-governmental Organizations (NGOs) and Community Based Organizations (CBOs). These were the channels through which specific sectors and marginalized groups were to engage the LAs in development discussions and processes. There are recorded achievements by these organizations. Devas (2002) as quoted by Grant (2002) notes *"In one of the case studies, the county council made contact with more than 200 community organizations and held 56 local meetings to raise awareness of the process before holding meetings in each of its wards to prioritize projects*" (Devas, 2002 pg. 314). Even though there was significant progress made in increasing public involvement in the planning processes, a number of challenges still existed. The formation of most of these Civil organizations, NGOs and CBOs were politically instigated or motivated (Ngau, 2013) or were for specific business interests (Grant, 2003; Onyach-Olaa, 2003). Therefore, their perceived fight was to secure their own interests and not that of the general public, especially the poor and marginalized. Further, LAs had the exclusive right to decide which organization to invite to planning forums. As such, they would not invite any group considered unfriendly or those that would demand accountability from them.

Moreover, most LAs still exercised the final right in decision making. As a result, most processes and decisions were done behind closed doors (Grant, 2003), away from the public and were therefore not transparent. The public never had the opportunity to participate in this final but critical stage.

The current urban spatial structure in Kenya owes its genesis to the application of laws and other instruments that were domestic in Europe but domiciled in their colonial territories (Ngetich, Opata, & Mulongo, 2014). The Physical Planning Act (PPA) CAP 286 of 1996 which replaced the land planning Act Cap 303 and the Town Planning Act Cap 134 of 1948 provides legitimacy and regulation for urban development control. The PPA CAP 286 provides for physical planning at three different levels. These include National, Regional and the Local Level. It also bestows the powers to control physical development on the local authorities under Schedule V of the Act (GOK, 2002).

The Act gives authority to the Director, Physical Planning to prepare National, regional and local development plans on behalf of the Government as detailed in Annex 1. Local authorities also exercise development control as provided for in the constitution and the city by-laws.

In development control, the constitution mandates the local authority as the regulatory and approving body. For any developer, application to change use or subdivide a parcel of land must be submitted to the local authority. According to the PPA Act and the County Bylaws, the same application must as well be published in a local daily and also displayed on the site of development. At the expiry of the notice, the local authority may approve or disapprove the application

In the year 2010, Kenya enacted a new constitution that devolved functions to the county governments. This presented greater opportunities for bringing power, control and influence closer to the people (Ngau, 2013). County governments were empowered to make independent planning decisions, albeit with

some level of supervision from the central government. The role of public participation in planning was recognized in different clauses and levels in the Kenyan constitution (see Annex 1 in the appendix)

Two basic challenges have faced county governments as far as public participation and collaboration in decision making is concerned. In his earlier work, Onyach-Olaa (2003) noted that *"local history, politics, tradition and skills/capacity, all influence local governments' response to changes in rules and procedures. These conditions also affect the ways in which local governments interact with community organizations, informal leaders, contractors and so on. Local leaders' political skills are easily overstretched and resources are lacking. Initiatives can also be undermined by local government resistance"* (Onyach-Olaa, 2003 pg 310). This has also been seen in the newly formed county governments, more specifically resistance to change. Secondly, many decentralized county governments are often unfamiliar with or lack the skills to make use of new instruments for citizen participation. Further, they have failed to harness new technological methods for citizen participation and stakeholder collaboration. Resistance to change (Ngau, 2013) and lack of political goodwill (Grant, 2003; Ngau, 2013; Onyach-Olaa, 2003) have also been cited as other reasons hindering the full implementation of citizen participation and collaboration.

2.6. Planning Support Tools for Public Participation in Spatial Planning

Technology has significantly changed how spatial information is managed and manipulated to produce desirable results. It has provided faster and efficient channels through which spatial information is communicated to the users. This section discusses the transformations in technologies that support public participation in spatial planning and how they have impacted the way in which spatial information is managed and communicated to users.

2.6.1. Participatory Geographic Information System

Geographic Information System (GIS), a computer system for capturing, storing, checking, transforming and displaying spatial data (Sieber, 2007), has grown to be an essential element in spatial planning. Participatory Geographic Systems (PGIS), a practice based on using geo-spatial information management tools to represent peoples' local spatial knowledge in the forms of virtual or physical 2 or 3 dimensional maps, has been used widely in various fields. These fields include participatory mapping (IFAD, 2009), Environmental Impact Assessment (EIA), Strategic Environmental Audit (SEA) (Walker et al., 2014), Disaster risk assessment, Natural hazards assessment, Health risk analysis, (Jelagat & Barasa, 2013; Sexton, 2013) urban growth form analysis (Cuca, Brumana, Oreni, Iannaccone, & Sesana, 2014; Dambruch & Krämer, 2014), community resource mapping, management of natural resources (Alarcon et al., 2011; Pelzer et al., 2014) among many others. PGIS can be used as interactive vehicles for discussion, information exchange, analysis and support (adding authority to local knowledge and community confidence) in advocacy, decision-making and action-taking. Practitioners can use the outputs of PGIS to support their planning arguments.

For PGIS, a variety of tools, methods or approaches can be used for geo-spatial data collection, modelling and representation. These include ephemeral mapping (drawn on the ground, in sand, etc.),

sketch mapping, scale mapping, spatial information overlays onto aerial photographs and satellite imagery; community surveying of new information using Global Navigation Satellite Systems (GNSS) technology, dynamic web-based mapping and map representation, Volunteered Geographic Information (VGI), web-based geotagging, mobile GIS, virtual globes, participatory 3-D modelling (P3DM) etc. (Alarcon et al., 2011; IFAD, 2009; Weiner & Harris, 2008).

Recent research has observed the introduction and rigorous use of Planning Support Systems in spatial planning. Pelzer et al. (2014) attributes this trend to the enormous improvements of models, software and hardware that have made it easier to connect these systems to planning practices in a more flexible way. In the study of the added values of PSS, Pelzer et al. explores the different aspects of added value by evaluating different software used in Group Decision Rooms (GDR), an electronic meeting room that 'enables fast and efficient stakeholder dialogue with real-time exchange of opinions, feedback of results, brainstorming and discussions' (Pelzer et al., 2014 p. 20). The software is embedded and used in MapTables developed by Mapsup (http://www.mapsup.nl). Their choice of the MapTable was informed by its ability to facilitate group interaction. This affirms the assertion by Vonk and Ligtenberg (2010, p. 167, as quoted by Pelzer et al. 2014) that a PSS must explicitly facilitate group processes and collaboration. This is in contrast to traditional PSS that often built on the single-user desktop computer which doesn't support multi-user collaboration.

The evaluation studies by Pelzer et al (2014) were carried out in Utrecht where a zoning plan was to be developed for a new neighbourhood with an ambition to grow to 8000 dwellings and to achieve an above average level of sustainability. Using the MapTable PSS and a Sustainability Profile of the Location (SPL- an indicator system of environmental values, with rankings as 1 being the lowest and 10 the highest), planning interventions were evaluated against the visible effects on one or multiple SPL themes. Pelzer et al. note that the use of MapTable PSS enabled the combination of strong analytical focus based on SPL methodology with the collaborative aim of working together among different disciplinary experts around the MapTable. Another example on the successful use of MapTables for participation is the application of MapTable to communicate with local residents where tentative plans are depicted on the MapTable by Rijkswaterstaat, the Dutch Ministry of Infrastructure and the Environment. This allows local residents to gather information and provide input on plans (Pelzer et al., 2014).

Pelzer et al. (2016) further performed case study evaluation of Achterhoek (Netherlands) where CommunityViz in MapTable was used to assess how Tradable Area Development rights could lead to better planning as well as inform policy makers about deprived neighbourhoods. They also evaluated the added value of SprintStad, a serious gaming application aimed at encouraging Transit-Oriented Development (TOD). In their study, Pelzer et al. (2016) conclude that the most important added value of PSS application is learning, both about others and about the object. These studies demonstrate the participatory use of GIS to aid and inform decision making in different set ups.

Efforts to improve digital information sharing and coordination among producers of fundamental data via spatial data infrastructures has increased over time (Georgiadou et al., 2011). While PGIS is more

about processes and outcomes, Volunteered Geographic Information System (VGIS) is more about application and large data. According to McCall, Martinez, & Verplanke (2015), the concept of VGI came from practitioners, users, and researchers in GI Science who were more interested in the information itself than in whether it was a participatory process that created it. VGI is concerned more with the approaches, systems, and modalities of gathering and organizing citizens' local spatial knowledge. Common examples include Web 2.0, OpenStreet Map, geotagging, geocoding, GPS, dynamic visualization of 3D objects like in Google Earth etc. A good example is presented by Zook, Graham, Shelton, & Gorman (2010) on a wide array of uses of VGI in Haiti. Zook et al. (2010) outline the ways in which VGI was used in the Haiti relief effort, especially with respect to web-based mapping services. They observed that VGI and crowd-sourced disaster response played an integral role in Haiti relief efforts, and that the crisis clearly resulted in a much greater availability of geo-coded data about Haiti.

Participatory mapping has been practised in several countries, both manually and digitally. IFAD offers a broad definition of participatory mapping as the creation of maps by local communities, with the involvement of supporting organizations including various levels of governments, non-governmental organizations (NGOs), universities and other actors engaged in development and land-related planning (IFAD, 2009 p. 4). Participatory mapping is heralded for its role in providing a valuable visual representation of a community's significant features, helping marginalized groups work towards legal recognition of customary land rights, recognising community spaces through identifying and demarcating traditional resources and helping in pre and post conflict resolution (IFAD, 2009). Manual methods of performing participatory mapping include mental mapping, ground mapping, participatory sketch mapping, transect mapping and participatory 3-dimensional modelling. Advancement in computer and internet technology has seen the rise in use of technically advanced GIS technologies. Typical examples of modern participatory mapping approaches include Flikr, Wikimapia, OpenStreetMap, Google My Maps, Green Maps and mobile GIS where users can input georeferenced locations on existing web maps using their GPS-enabled mobile phones. In OpenStreetMap, users can voluntarily update feature locations on the map with ease.

2.6.2. 3D Modelling and E-participation

Visualization of geographic phenomena has been in practice for over a thousand years, as presented in Section 1.2. Two-dimensional (2D) visualisations that have always been used to present geographic information were and still are difficult to understand (Milosz et al., 2007), especially for stakeholders who have little or no experience in interpreting maps. 3D visualisation present new flexible techniques with greater potential for increasing stakeholder understanding of plan presentations.

There exists sufficient evidence that 3D visualisation tools are capable of exciting and stimulating stakeholder involvement. In their study in Catolina titled 'Raising awareness for participation through interactive geo-visualization in Catolina', Irene and Rosa, as quoted by Adri et al. (2007), report that "*the various groups of people that have participated have been very positive about the usefulness of the technology. Spatial planners even considered these tools to be potential solutions to some of their most common communication problems with citizens*"

(Adri et al., 2007 p. 60). Koeva, (2016) in her study of the creation of interactive web-based visualization of cultural heritage projects is Sofia (Bulgaria) concludes that "image- based modelling and panoramic visualisation are simple, fast and effective techniques suitable for simultaneous virtual representation of many objects" (Koeva, 2016 p. 6). In Korea, Kim discusses the use of 3D simulation and visualization techniques for various applications including development control (Kim, 2005). Simão further describes a web-based tool for collaborative planning and public participation and its effectiveness in the United Kingdom (Simão et al., 2009). Al-Hanbali, Fadda, & Rawashdeh (2006). in their work present 3D modelling in GIS environment as a way of offering a flexible and interactive system for providing the best visual interpretation, planning and decision making process. Due to the fact that most people are not able to read architectural drawings or detailed plans but can easily relate with physical models, 3D digital models makes it possible even for non-experts to exert more control over what they wish to see as opposed to what the planners want them to see (Al-Hanbali et al., 2006). Other examples as well as their benefits are described in section 1.2.

Barton, Plume, & Parolin, (2005 p 634) opine that 3D visualization and E-participation (remote participation through web based forums and phone applications) promote the development of different perspectives of reality through inclusive interaction of stakeholders by identifying goals, insights, interest and starting points in the planning process.

2.6.2.1. 3D Modelling and Geo-visualization

Spatial information can be captured, processed, manipulated and transformed into either 2D or 3D models. Modelling is based on the concept of generalisation, defined by International Cartographers Association (ICA) as "the selection and simplified representation of detail appropriate to the scale and/or purpose of a map" (ICA, 1973). The technique involves selectively choosing the most important spatial features to represent, combining small features and simplifying complex ones while simultaneously removing unnecessary details (Babic, Nesic, & Miljkovic, 2008; Butwilowski, Thomsen, Breunig, Kuper, & Al-doori, 2015; Thakur, Banerjee, & Gupta, 2009). During the simplification process, extracted features are evaluated and removed based on the intended purpose, use and users. Reviews of different simplification approaches can be found in Babic et al. (2008) and Thakur et al. (2009).

Besides simplification, there are a number of approaches for generalizing models. (Xie, Zhang, Li, Wang, & Yang, 2012) details characteristic building structures in a surface model, which are preserved in a merging process of surface parts. In the approach by Forberg (2007), a building model is transformed into a new 3D representation based on scale-space approach. This works by moving parallel facets towards each other until a 3D feature under a certain extent is eliminated or a gap is closed. Different approaches for generalization of 3D models can also be found in review articles by Biljecki, Ledoux, & Stoter (2016), Boguslawski, Gold, & Ledoux (2011) and Mao & Ban (2013).

Models are developed based on thematic or domain-specific needs, application and generalizations. Even though they are detailed construction models, Building Information Models (BIM) have been used in spatial planning to make realistic 3D representations useful in simulating in different scales physical urban

phenomena. This aids in spatial decision making for city planning. The development of BIMs is guided by standards specific to a domain. One such BIM is the building model of the City Geography Markup Language (CityGML) which allows the representation of buildings at five different levels of detail (LoD). These levels are explained in section 3.4.2.

2.6.2.2. E-participation: The Worldwide Web (www) and mobile phones.

To ensure meaningful participation of the public in planning and decision making processes, communication tools must be provided. However, 'genuine' communication between planners, citizens, decision makers and other stakeholders cannot be achieved without an open process that ensures the participation of all citizens and stakeholder groups.

The internet was meant to connect people, communities, and countries around the world (Hansen & Prosperi, 2005; Peng, 2001). The invention of the World Wide Web (www) by Sir Tim Berners-Lee in 1989 significantly changed the way people communicated and exchanged information. Since then, the internet has provided a channel through which people, governments and other institutions communicate and exchange information seamlessly.

The internet has provided an opportunity for government agencies to engage stakeholders in planning and decision making. Karakaya (2003) argue that technology can be used by local authorities to increase their internal efficiency, have better communication with their partner organisations as well as join up their services with them. According to Peng (2001), the internet can become a forum around which community-based issues, information, alternative perspectives, and decisions evolve. Hansen & Prosperi (2005) affirm that the internet has the potential of being a strong medium for involving the citizens in decision-making. The web enables collective intelligence and collaborative content creation and linking by the user who contributes towards common knowledge (Porwol, Ojo, & Breslin, 2014). It also allows for interactivity between individuals and data, individuals across departments, groups between themselves or interdepartmental interactivity.

The development of the internet and advancement in GIS technologies has made it easier to provide access to and disseminate spatial information and even conduct GIS analysis. Furthermore, it has provided new ways of presenting high resolution visual information through the integration of high resolution data with spatial geo-information in spatial databases. The integration of GIS, Virtual Reality (VR) and the Internet through Virtual Reality Modelling Language (VRML) for spatial data visualization, analysis and exploration takes advantage of each component, and enables dynamic 3D content to be built, visualized, interacted with and disseminated across the Web (Huang & Claramunt, 2004; Pundt & Brinkkötter-Runde, 2000). Convergence of networking and computer graphics (Huang, 2003; Huang & Claramunt, 2004; Pundt & Brinkkötter-Runde, 2000) provide some valuable solutions for the dynamic, visual and multi-dimensional exploration of spatial processes. This has changed ways of visualization from the traditional pen-paper and physical 3D models to the more sophisticated but flexible modern GIS and web-based visualization technologies. Figure 3 summarises the historical transformation of visualization techniques and tools.

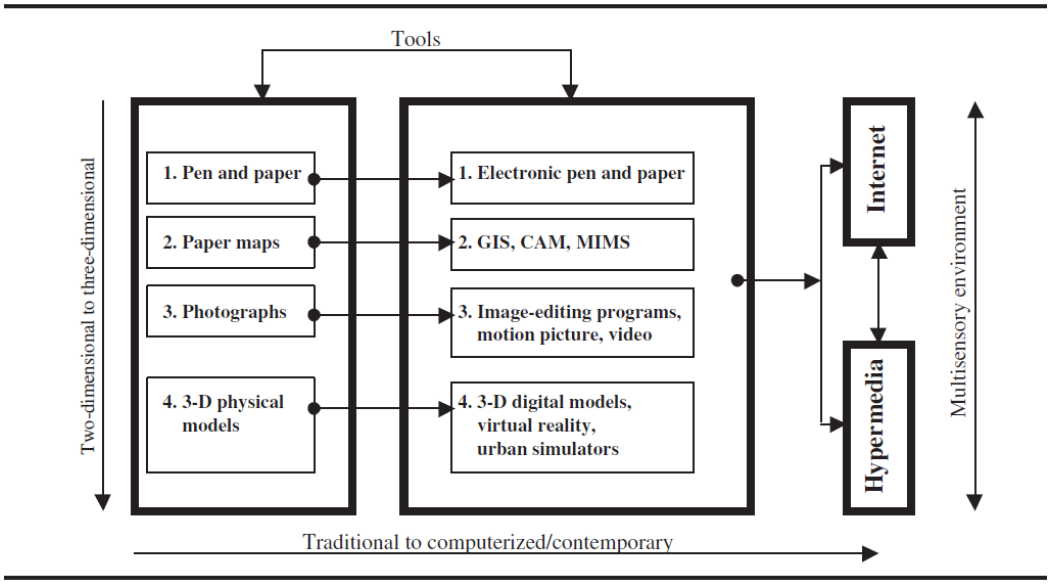

Figure 3: Progression of Visualization Tools from Traditional to Computerized/Contemporary. Adapted from K Al-Kodmany (2002)

Until recently, the use of spatial data with Web technology has largely been limited to the provision of information to the public rather than any actual public participation. While local governments, planners, civil groups and community agencies frequently utilize the web to offer information to community members (Al-Kodmany, 2001; Hudson-Smith et al., 2005; Pettit, Raymond, Bryan, & Lewis, 2011; Pundt & Brinkkötter-Runde, 2000), it has been less common for these entities to use the Internet as a medium for two-way communication.

The internet overcomes two main obstacles in the traditional methods (town hall meetings/public hearings) of public participation: the dominant vocal few and the inflexibility of meeting time (Peng, 2001). Nevertheless, Internet may not be the ultimate solution for low levels of participation. People may still continue to abstain from participating especially if they do not believe that their participation will make a difference (Karakaya, 2003). The internet only introduces easier ways of communication and hence potentially makes dissemination of information and participation easier.

Widespread availability of mobile phones has enabled real time participatory applications ranging from reality television opinion voting, reporting traffic congestion, crime reporting, banking, charity donations and dissemination of various kinds of information. The progressive use of mobile phones has enabled the acquisition and utilization of spatial data easier, faster and cheaper compared to the traditional conventional ways which are costly and time consuming. Mobile phones have provided opportunities for governments and other planning agencies to explore different ways to interface with citizens, not only in the provision of information, but also to engage in dialogue (Van Belle & Cupido, 2013).

According to Van Belle & Cupido (2013) mobile phones have become effective tools in facilitating information sharing between a large number of similarly minded people within a short period of time and at short notice. Today, there are hundreds of free downloadable mobile applications that can aid in real

time georeferenced spatial data collection and transmission, for example "Collector" for ArcGIS developed by Esri.

While the current position of mobile phones as a platform to encourage participation is without question (Van Belle & Cupido, 2013), there are concerns around personal privacy and security. South Africa's award-winning 32211 SMS tip-off crime line presents a success case study of the minimization of this fear where anonymity is guaranteed, not by government or the police, but by private enterprises (Van Belle & Cupido, 2013).

The worldwide web and mobile phone technologies have opened newer fronts of enhancing E-participation. This has made the business of information gathering and exchange and the actual participation easier, faster and cheaper.

2.7. Conclusion.

Karakaya (2003) noted that people may abstain from participating if they believe that their participation may not make a difference or may not even be considered in the first place. However, it is important to note that for the success of any planning initiative, the involvement of the public is paramount. It is therefore prudent to device ways in which the public are presented with open and transparent opportunities to participate. As discussed in this section, presenting planning scenarios in near reality improves the understanding of participants without proper cartographic skills. 2D maps and plans commonly used by professionals, as noted, are sometimes hard to understand and interpret, especially for non-cartographers. It is therefore important that any planning tool and materials used in planning representation should be substantively flexible and understandable to all users. Similarly, different communication channels should be explored, both paper-based and electronic, in terms of their possibilities to offer interactivity, information exchange and feedback mechanism.

3. METHODS AND MATERIALS.

3.1. Introduction.

This chapter describes the different methods used to carry out the research and the data requirements. Data preparation and separation of fieldwork tasks is also discussed in this chapter. It further presents the tools and techniques used in carrying out data analysis.

3.2. Study Area

Kisumu is an inland port city on the shores of Lake Victoria, Western Kenya, covering an area of about 417 Square Kilometres. It is located on 0.0917° S, 34.7680° E at an altitude of about 1131m ASL. It is situated on the North tip of Winam gulf, part of Kavirondo Gulf of Lake Victoria. Kisumu is the third largest city in Kenya after Nairobi and Mombasa, with a population and population density of about 409,000 and 460/km² (1,200/sq. mi) respectively (KNBS, 2015). The city is the headquarter of the larger Kisumu County. Figure 4 shows Kisumu in the national context.

Kisumu has an annual relief rainfall of between 1200 mm and 1300 mm. The rain mainly falls in two seasons; the long rains in April and the short rains in September. The area is known for its thunderstorms, and is warm throughout the year with a mean annual temperature of 23°C (ASDSP, 2016). Temperatures range between 20°C and 35°C but seldom fall below 19°C.

Kisumu is believed to have started long before the arrival of the *'Lunatic Express'* in 1901, the railway line connecting the port of Mombasa to Uganda. The place was a meeting point where traders exchanged goods for goods, or others sought food and other commodity assistance, hence the name Kisuma, a place to look for food in times of need (Figure 5 left). The non-natives, the Indian railway workers and the British colonialists, found it hard pronouncing the name Kisuma (The Standard, 2012). The name Kisumu was thus corrupted out of the original name.

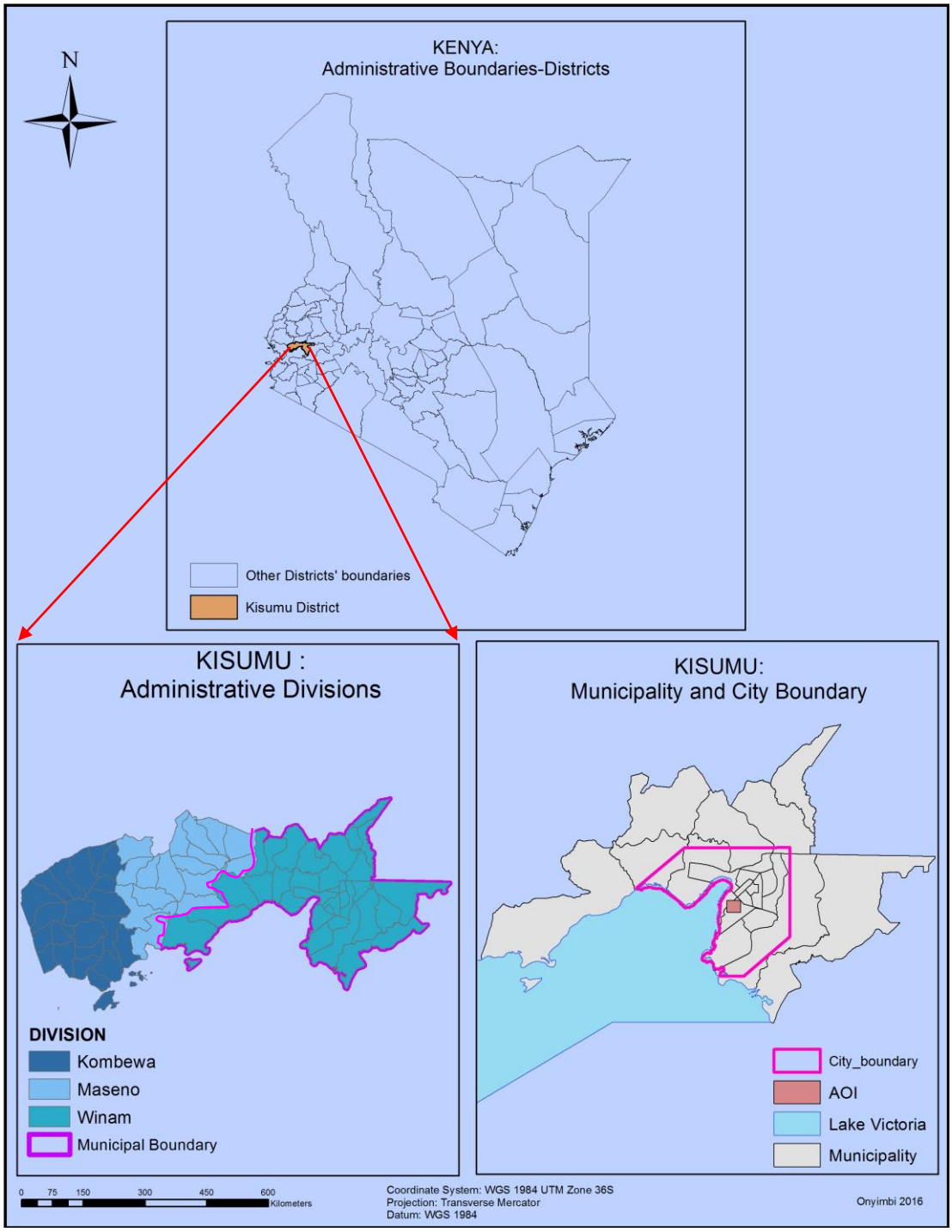

Figure 4: Kisumu District in a countrywide context.

On 20 December 1901, Florence Preston the wife of the engineer in charge of the railway construction opened the new port by the shores of Lake Victoria (Figure 5, right). The port was named Port Florence but reverted to its former name - Kisumu after one year.

Figure 5: Left-Right: Kisumu market. Completion of railway and the laying of foundation stone for the port by Florence Preston. (Courtesy Kisumu Museum).

Kisumu became the most important harbour on the lake and enjoyed prosperity until the collapse of the East African Community in 1977 (EAC, 2015). Passenger and cargo ships sailed the lake for many years between the three countries - Kenya, Uganda and Tanzania. Passenger services ceased in the early 1990s, while cargo services collapsed in the 2000s (The Standard, 2012). The government has however indicated its intention to revive the port through partnerships with other development agencies (Daily Nation, 2016).

Figure 6: left –right: Kisumu port, Water hyacinth invasion and a dilapidated passenger ship

The invasion of the lake by the hyacinth weed (Figure 6) has made water transport and fishing as an economic activity a nightmare to the locals (Wagah, Onyango, & Kibwage, 2010). Today, most cargo and passenger ships docked at the port lie in dilapidated state (The Standard, 2012).

Administratively, Kisumu District is divided into 3 Divisions of Winam, Kombewa and Maseno with 10 locations (Figure 4). Kisumu city falls within Kisumu Municipality in Winam Division and is divided into 14 different planning blocks as shown in Figure 7. Different blocks fall within different planning zones. The urban area is predominantly used for commercial purposes while the fringes harbour most of the residential housing (both high and low density).

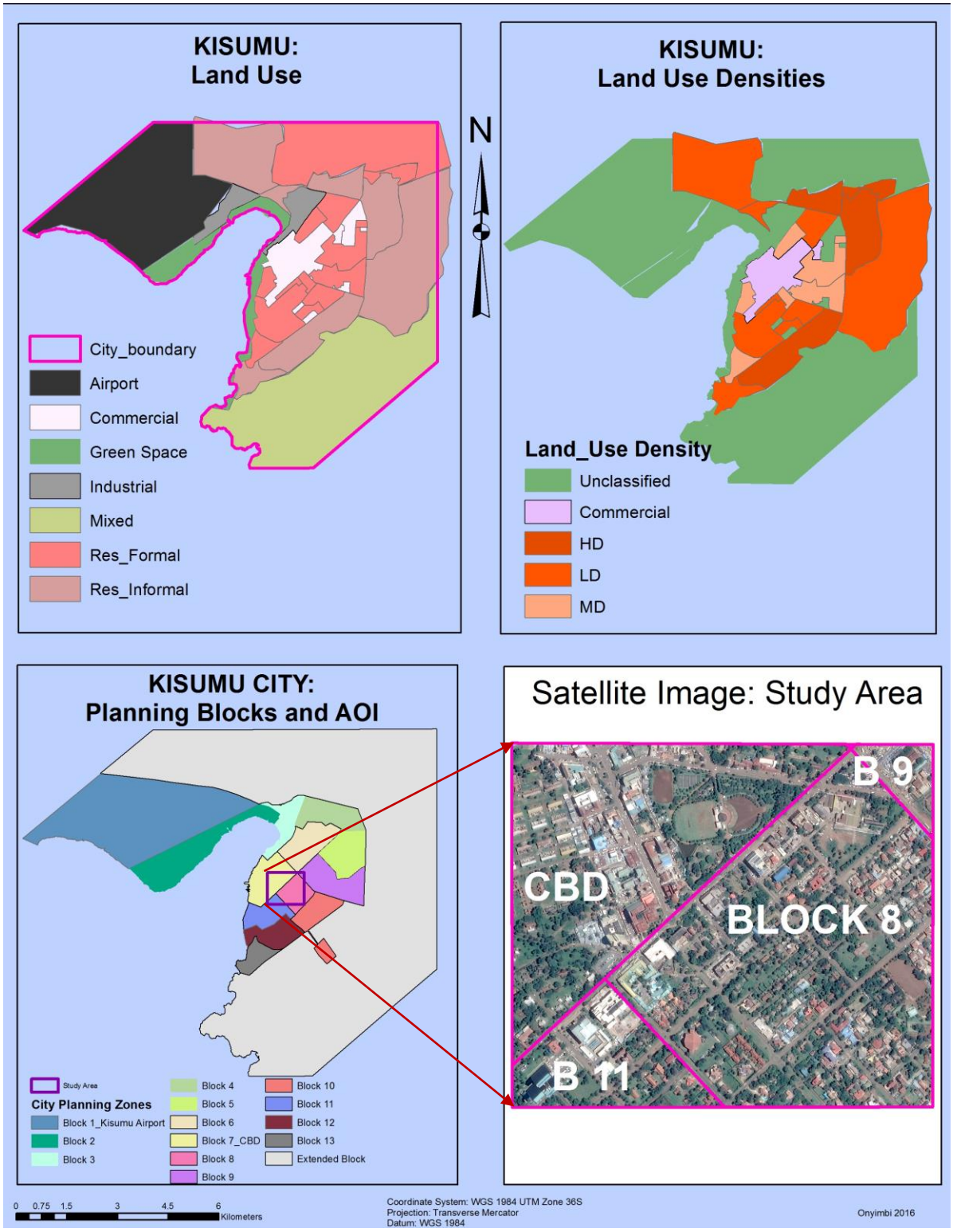

Figure 7: City land use and density maps and The Study Area (CBD and surrounding Blocks)

The main economic activity is fishing. However, rice, sugar and cereals production is also practised around Kisumu. The city serves as the communication and trading confluence for the Great Lakes region - Tanzania, Uganda, Rwanda and Burundi (Wagah et al., 2010). Administratively, the city is headed by a city manager, and all planning and administrative work is done through the City Council of Kisumu.

Kisumu city has been chosen for this study for two reasons. First, little or no research has focused on how 3D visualization and E-participation can be integrated to improve public participation particularly in Kisumu. Globally, most researches have focused only in either of the two. Al-Kodmany's (2001) work only looked into online tools that can improve public participation. Other similar works focused mainly on visualization (Huang, 2003; Lovett, Appleton, Warren-Kretzschmar, & Von Haaren, 2015; Martin Dodge, 2008; Métral, Ghoula, & Falquet, 2012; Ware & Plumlee, 2005; Xu & Coors, 2012; Zhang, Zhang, & Xu, 2016) while others centralised their research on participation (Bingham et al., 2005; Enserink et al., 2006; Okello et al., 2012; Sexton, 2013; Simão et al., 2009; Walker et al., 2014). This existing gap formed the basis of this research.

Secondly, the author has local knowledge and understanding of the city. This made it easier in carrying out fieldwork, especially in administering questionnaires. Lastly, the city still has great potential for growth and expansion. According to Kenya Economic survey 2015 (KNBS, 2015), Kisumu is fast growing and has more potential for growth especially in the construction sector. The Central Business District (CBD) and parts of its immediate surrounding blocks (blocks 7, 8 & 11) has been chosen as an area of interest (AOI) since it has experienced massive restructuring and conversion of old houses into large business complexes. Similarly, this area has well defined and visible street patterns and building structures easily distinguishable from aerial and satellite imagery.

The success of this study in the chosen neighbourhood presents an opportunity to replicate the same for the whole city by using 3D visualization and E-participation in enhancing collaboration and participation. This is a new front since there has never been a study in Kisumu city on the integration of 3D visualization and E-participation into the planning processes.

3.3. Overview of Data Requirements and Methods

This section highlights the process carried out before, during and after fieldwork. It also enlists the tasks carried out and the data used during the study and how they were obtained.

3.3.1. Pre-fieldwork data preparation

This stage involved the assembly of dataset for the design of the 3D city model. Vector data was obtained from the local government while raster data was obtained from DigitalGlobe.

Another step involved the design and testing of survey questionnaires, workshop task sheets and Key informant interview questions. At this stage, various fieldwork interviews were pre-planned in consultation with the local authority and the key informants.

3.3.2. Data Available

The data for the generation of 3D model and visualization (Table 2) were obtained from various sources. This includes the local authority, on-screen digitization from OpenStreet map, Shuttle Radar Topography Mission (SRTM) and DigitalGlobe.

Table 2: List of dataset available and their sources

Data Available	Acquisition dates	Type	Source
Vector Data: Building footprints, heights, Roads, land use, Parcel Boundaries)	2016	Shapefiles	SRTM, OpenStreet Map (digitising), City government of Kisumu.
Raster Data: (2 Satellite Images) Digital Elevation Model (DEM),	2009	Mono, Tiff	Geoeye satellite (Via DigitalGlobe)
Population	2009	Statistics	Socioeconomic Data Application Centre (SEDAC) and Kenya National Bureau of Statistics (KNBS)

Data on user perception and other socio-economic characteristics of the users were collected during fieldwork. Table 3 indicates the types of data collected and their sources.

Table 3: List of data collected in the field and their sources

Data collected	Acquisition dates	Source
User perceptions, Usability, factors influencing participation.	Field	Interviews, Questionnaire, Workshops
Prepared plans, comments received and level of participation achieved.	Field	Key informants, Data from County Government of Kisumu
Socio-economic Characteristics	Field	Literature review, Interviews, Workshops, KNBS, Questionnaire,

3.4. Research Methods and Design

This is an applied research. The output can be used for participatory and collaborative decision making in multiple planning areas. This study was carried out in three phases; the pre-field work, field-work and post field work phases. Pre-field work phase involved societal problem identification and the justification for this study. Extensive literature review was carried out to provide insight into technological developments in visualization and communication. At this stage, the objectives of the study were set and the guiding questions established. Other important study materials like questionnaires and interview questions were developed. The 3D model was created and exported into an online geo-portal provided by ArcGIS Online for later use during field workshops. The questionnaires and interview questions were pre-tested locally to help refine them before the actual fieldwork. Fieldwork entailed the organization and execution of the field workshops to test the created tools using different tasks and indicators. It is at this stage that interviews and surveys were conducted and data recorded. Post fieldwork entailed the processing of collected data from the surveys, key informant interviews and the workshops conducted.

Analysis and reporting formed the last steps of this study. The process is summarised in the workflow in Figure 8.

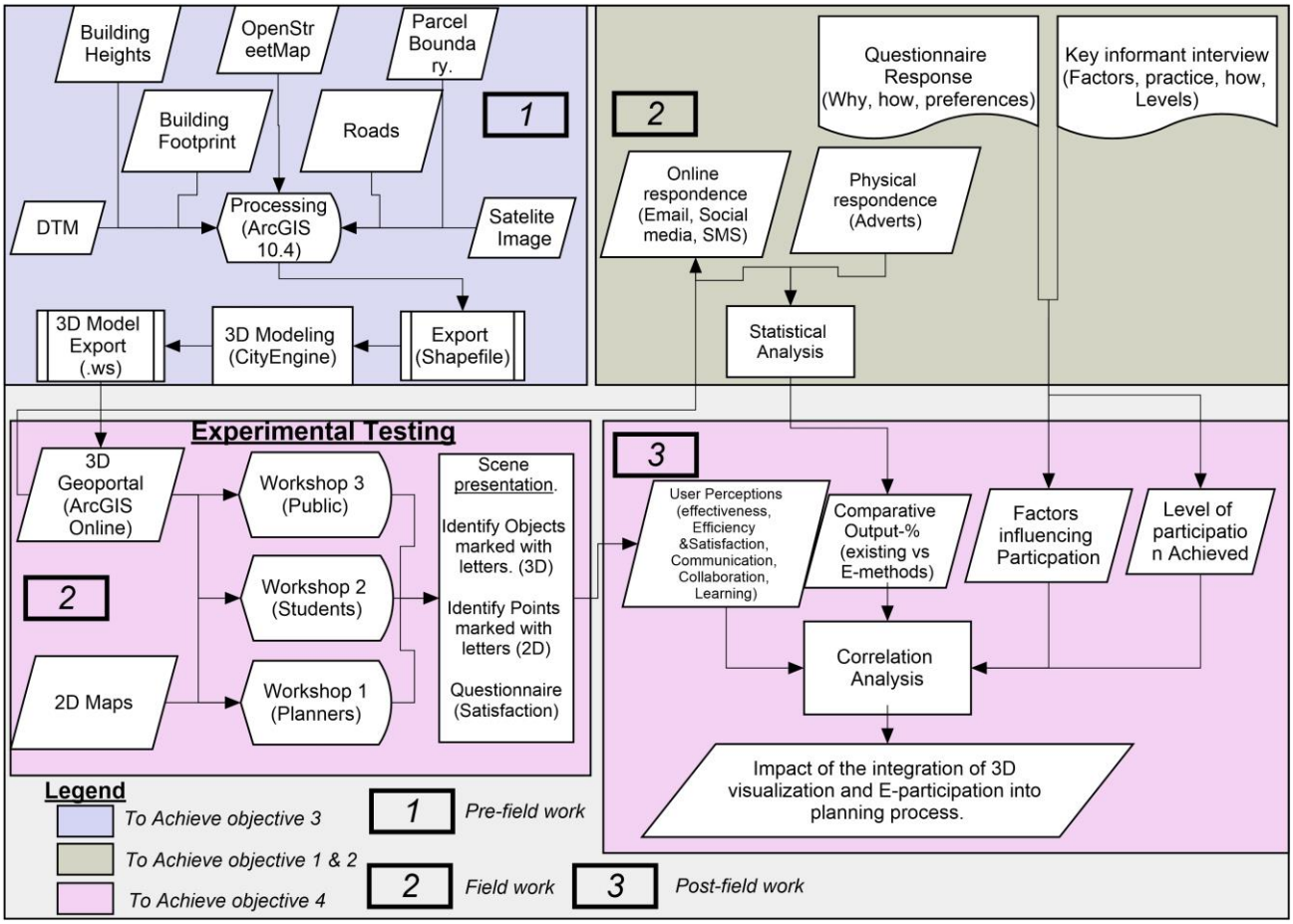

Figure 8: Overall study workflow.

3.4.1. Analytical Framework

Visualization of information is strongly related to human perception, behaviour, and interaction. In the domain of visualization, human perception and visual information processing plays an important role. According to Lovett et al. (2015) and Wanarat & Nuanwan (2013), visualisation offers a method for seeing the unseen through the conversion of abstract data into concrete visual representations. Often, it involves the use of more than one medium (text, still graphics, computer models, and animation).

The impact of any planning support tool can be evaluated based on its perceived added value, defined by Pelzer as a positive improvement of planning practice, in comparison to a situation in which no such tool is applied (Pelzer et al., 2014). Different scholars have fronted different methods to assess added value. Pelzer & Geertman (2014) in their study of perceived added value using group decision rooms concluded that improved communication and collaboration were the perceived added values of the PSS from the practitioners' point of view. Goodspeed and te Brömmelstroet, as quoted by Pelzer (2015) included impact analysis, and found out learning and learning effects respectively as important perceived added values in their studies. van de Ven et al. (2016), in their development and evaluation of an Adaptation Planning Support Toolbox (APST), identified convergent learning as the key added value of such a tool.

They concluded that such a tool should provide "a converging learning process that leads to a final positive decision on an adaptation plan". Some researchers have identified usability and effectiveness (Pelzer et al., 2014) as important aspects of added value, while others have pointed out consensus, efficiency and better informed outcomes (Pelzer et al., 2014; van de Ven et al., 2016) as potential added values.

It is sometimes hard to properly identify the effect of independent variables on the added value of PSS, but this can be done in controlled environments. This informed the choice of using the 3D model as a PSS tool in the controlled workshops as explained in the subsection 3.4.3. However, in reality and planning practice, applying PSS in a controlled setting or replicating the experiment may sometimes be hard or unrealistic. Perceived added value is therefore inherently dependent on the context in which it is used, the characteristics of the users, the support capabilities of the PSS, the process and the unique content of the planning issue at hand.

3D models can be used as a planning support tool in the spatial planning domain. The models can be used to present planning scenarios to stakeholders using different channels. Presented in web portals, these models can be used to facilitate information exchange, learning, communication, collaboration and interaction between different users.

3D modelling in this study is grounded on the concept of "imegeability", defined by Kevin Lynch[4] as "…that quality in a physical object which gives it a high probability of evoking a strong image in any given observer. It is that shape, colour, or arrangement that facilitates the making of vividly identified, powerfully structured, highly useful mental images of the environment. It might also be called legibility" (Lynch, 1960 p 9). One component of imageability is the usability of the support tool created. To accomplish this study, Usability was adopted as proposed by ISO 9241-11[5] standards, defining it as the extent to which a geo-visualization can be used by actors in spatial planning processes to achieve specified goals effectively, efficiently and satisfactorily. This is also supported by Pelzer's work which identified usability (Pelzer et al., 2014) as one measurable of added value. According to the ISO 9241-11 standard, effectiveness describes the accuracy and completeness of goal achievement, efficiency measures the relation of effort and effectiveness with respect to goal achievement, and satisfaction comprises perceived comfort, absence of discomfort and positive attitude towards use of the product. There are a variety of ways of evaluating usability, but two groups are distinguishable: *Usability Testing* and *Usability Inspection* (Milosz et al., 2007). The difference lies in the level of expertise required to perform the evaluation. For Usability Inspection, the evaluation is performed by experts (Al-Kodmany, 2001, 2002; Milosz et al., 2007) while for Usability Testing, the designed product is assessed by end users (Al-Kodmany, 1999; Martin Dodge, 2008; Milosz et al., 2007). For this study, Usability Testing was adopted since it involved different users testing the developed 3D geo-visual model. In this study's evaluation methods, the three

[4] in his book *Image of the city*

[5] *https://www.iso.org/obp/ui/#iso:std:iso:9241:-11:ed-1:v1:en*

main factors for measuring Usability of visualizations are task completion time (faster interpretation-*efficiency*), task completion correctness (number of correct answers-*effectiveness*) and general opinions of the respondents (*satisfaction*). Aside from quantitative measures, qualitative user data has been assessed in the past to discover patterns in users' behaviour (Nazemi, Burkhardt, Hoppe, Nazemi, & Kohlhammer, 2015). This will be significant and will also be used especially in evaluating satisfaction.

While main focus will be on the usability aspect, other aspects as indicated in table 4 will also be looked into, albeit passively.

Table 4: Measurables used in this study

Measurable	Indicators	Measured via	Proposed by
Usability	Efficiency, Effectiveness, Satisfaction	Workshop tasks 1,2 & questionnaire	ISO 9241, Nazemi et al (2015), Pelzer et al (2014), Milosz et al. (2007)
Communication	Interaction, information exchange, Feedback, realism, Scene navigation, Flexibility	Workshop Questionnaire & General Survey questionnaire	Pelzer et al. (2014), van de Ven et al. (2016)
Learning	Improved understanding, Ease of understanding, Lessons learnt	Workshop Questionnaire, observation & Survey	Pelzer et al. (2014), van de Ven et al. (2016)
Collaboration	Interaction, information exchange, Feedback	Workshop Questionnaire, observation & Survey	Pelzer et al. (2014), van de Ven et al. (2016)

3.4.2. Modelling and visualization.

Extensive literature review was carried out on the guiding standards, different techniques, software packages and methods of 3D modelling.

Two broad approaches of modelling methods include Image Based Modelling (IBM) and Rule Based Modelling (RBM). Currently, there are software packages that provide opportunities for manual, semi-automatic and even automatic 3D IBM or RBM generation. A lot of effort has been put in by the computer vision community on assessing the feasibility of full automation (Koeva, 2016). Different software packages based on Structure from Motion (SfM) and automatic Image Matching (IM) techniques have been tested, achieving accuracies of less than 3.5mm (Frankl et al., 2015; Koeva, 2016; Köthe, 2003; Lowe, 2004; Rodriguez-Gonzalvez, Gonzalez-Aguilera, Lopez-Jimenez, & Picon-Cabrera, 2014; Zhou, Dao, Thill, & Delmelle, 2015). However, semi-automatic and/or even manual methods are still used, especially for complex structures where high accuracy for details is essential (Koeva, 2016; Yang, Chao, Huang, Lu, & Chen, 2013).

Recently, researchers have investigated the use of different methods of 3D modelling. Koeva (2016) explored the use of non-metric hand-held camera for IBM (3DIBM) of cultural heritage objects in Bulgaria. Luo, He, & He (2017) evaluated the use of RBM for supporting district protective planning in

China. In New Delhi, India, Gupta, Bhardwaj, & Kumar (2015) assessed the use of rule based 3D city modelling using high resolution satellite data while Paul, Subramanian, & Bharadwaj (2006) conducted an almost similar study on the creation of a digital city model from a single high resolution image. For this study, RBM was selected because it is more efficient and flexible to use in model generation for a large area, having a certain potential in supporting urban planning (Luo et al., 2017). The back-end operation of CityEngine is detailed under the sub heading '*procedural rule based modelling'*.

Modelling in CityEngine is guided by procedures and guidelines offered by CityGML. CityGML is the international standard open data model and XML-based format of the Open Geospatial Consortium (OGC) for storage, representation and exchange of 3D city models. It is an application schema for the GML version 3.1.1 (GML3), the extendible international standard for spatial data exchange issued by the OGC and the ISO TC211[6]. The standard includes two modules: the geometry model and the thematic model. The core module comprises the basic concepts and components of the CityGML data model, whereas the extension modules cover specific thematic fields of the virtual 3D city model including: Appearance, Bridge, Building, City Furniture, City Object Group, Generics, Land Use, Relief, Transportation, Tunnel, Vegetation, Water Body, and Textured Surface.

The modelling methods usable depend on the level of details to be represented, the data available and the intended use. CityGML offers 5 distinct Levels of Detail (LoD0-Lod4) with thematic and geometric features of objects increasing up each LoD. Esri's CityEngine offers a flexible opportunity to model cities in 3D in the different LoD's defined by CityGML. For this reason, CityEngine was chosen for the modelling process.

LoDs

As mentioned in the previous sections, CityGML offers 5 Distinct Levels of Detail (LoD). The Figure 9 below depicts the five LoDs.

The LoDs differ in detail. LoD0 represents the coarsest and least detailed level of modelling. It describes polygons embedded in 3D space where for each (x,y) coordinate there is at most one height value on the polygon. Volume objects like buildings are represented by a single horizontal polygon, either at roof or at footprint level (Gröger & Plümer, 2012). Example of LoD0 is a Digital Terrain Model (DTM), over which imagery can be draped.

[6] *http://www.opengeospatial.org/standards/citygml*

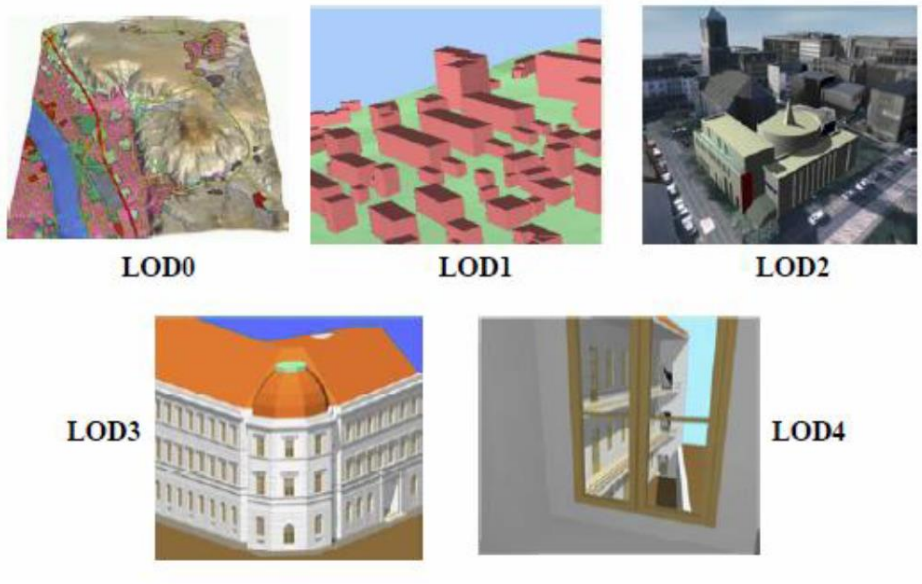

Figure 9: LoD as defined by CityGML (Images adapted from Gupta et al. (2015)

In LoD1, volume objects (e.g. buildings) are modelled in a generalized way as prismatic block models with vertical walls and horizontal 'roofs (Example in Figure 10). It is a model where blocks are extruded to specific heights with flat roofs (Gupta et al., 2015). LoD2 model is a textured model which differentiates between various roof structures. LoD3 is the architectural and most detailed level for the outermost shape of objects. It has detailed walls, roof structures, balconies and projections. LOD 4 is essentially a model of interiors of a building where interior structures (rooms, etc.) are added (Gröger & Plümer, 2012; Gupta et al., 2015). LoD4 is only provided for reasons of completeness if a feature doesn't have interior structures. The resolution of textures, which can be mapped onto nearly all features, also increases with higher LoD.

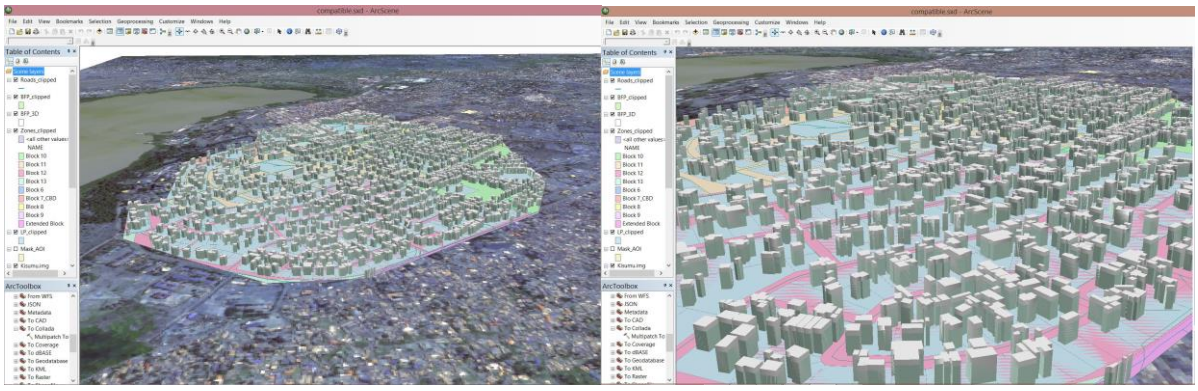

Figure 10: An abstract (block) model of Kisumu City Study Area (LoD1)

Data processing

The 3D model of the selected part of the city (Area of Interest) was reconstructed from a 0.50m resolution GeoEye Mono satellite image (2009). Additional data of parcel boundaries, transport network, administrative boundaries, building footprints and land use was obtained from the city government. These were also last updated in 2009. The flowchart in Figure 11 illustrates the procedure for modelling.

Data processing involved setting the modelling environment in ArcGIS 10.4.1 software to Transverse Mercator projection, WGS_1984_UTM_Zone_36S to enable smooth geo-processing. Afterwards, the accuracy of the dataset was tested by overlaying it with the GeoEye satellite, GoogleEarth and OpenStreet Map imagery. Additional data was downloaded from Openstreet Map as *.osm file. The downloaded street data was overlaid with the existing data obtained from the county government for accuracy comparison and updating where necessary. Missing roads and building footprints were digitized from OpenStreet Map in ArcGIS 10.4.1. Using the AOI described in sub section 3.2, all vector (shapefiles) and raster (DEM & Satellite Image) were clipped to reduce the size of the dataset and enhance faster processing. After the geoprocessing in ArcGIS 10.4.1, the dataset was transferred to ArcScene 10.4.1. In ArcSecene, building heights were used to extrude and generate an abstract 3D model in LoD0 and LoD1 respectively (Figure 10). There was no accurate data on building heights obtained from the Local Authority.

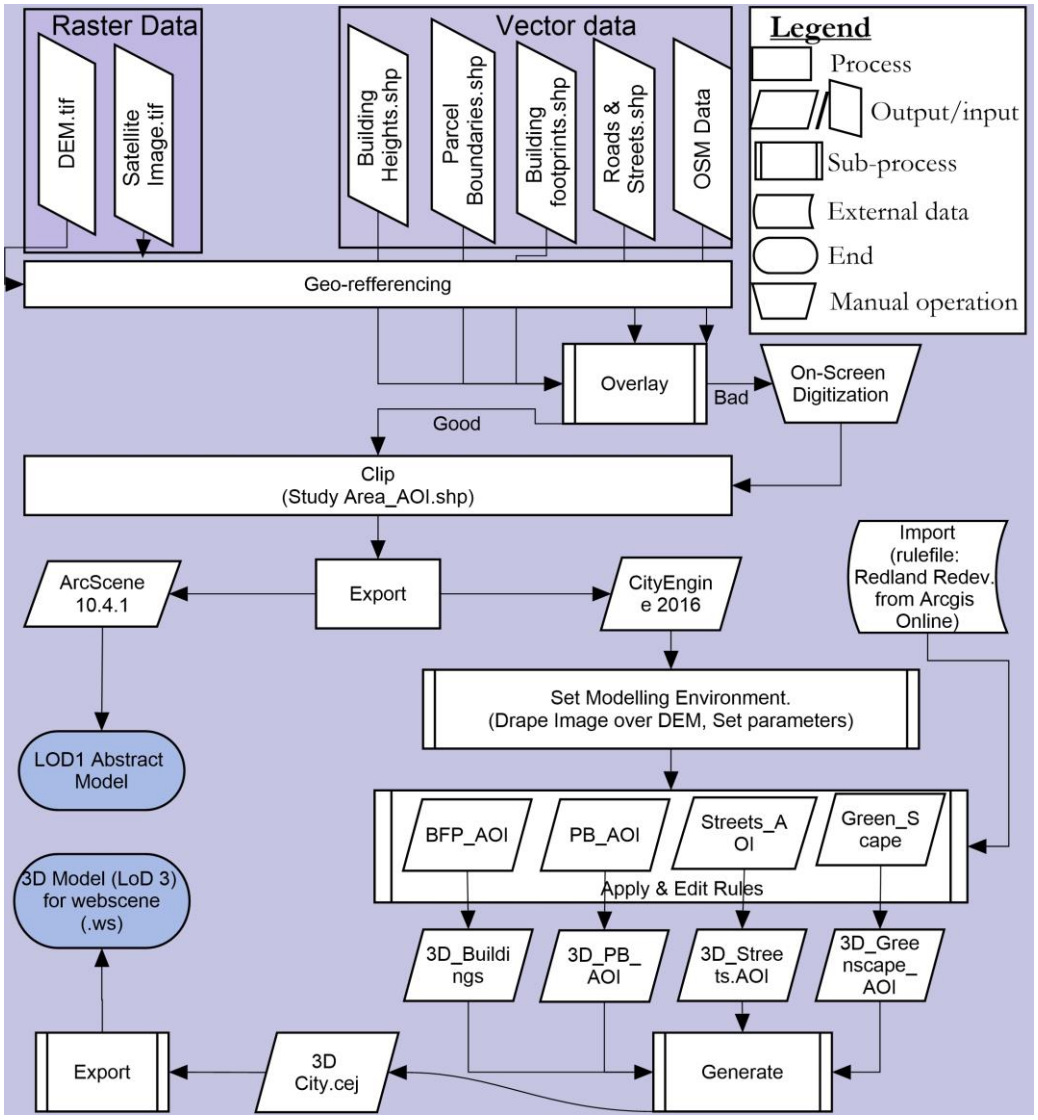

Figure 11: The 3D modelling flow chart

However, using local knowledge and online sources (google.com), building heights for major buildings in the CBD were estimated. The heights were calculated as the;

Height of ground floor + (1st Floor height * No. of floors)

In some cases, knowledge of the number of floors for buildings in the CBD enabled the automatic calculation of total height in CityEngine. Residential buildings in adjacent planning blocks have similar characteristics in terms of floor height, number of floors and roof type. It was therefore easier to edit a rule for one building and generalise for all buildings in the neighbourhood during model generation.

Procedural Rule Based Modelling

CityEngine provides tools for editing and texturing using Computer Generated Architecture (CGA) shape grammar-based 3D procedural modelling. CGA shape, a novel shape grammar for the procedural modelling of CG architecture, produces building shells with high visual quality and geometric detail. Procedural modelling of urban landscapes using shape grammar was first presented by Parish and Muller (Parish & Müller, 2001). In later works Müller, Wonka, Haegler, Ulmer, & Van Gool (2006) demonstrated how shape grammar could be used to develop rule files for large 3D city modelling. Context sensitive shape rules allow users to specify interactions between entities of the hierarchical shape descriptions (Müller et al., 2006; Parish & Müller, 2001). In their work, Parish and Müller justify that CGA shapes can efficiently generate massive urban models with unprecedented level of detail (Müller et al., 2006; Parish & Müller, 2001).

In CiyEngine, Each model is supported by a CGA rule file. In the rule file, various parameters of buildings such as height, floor height; wall texture, wall type, roof etc. can be defined, modified and/or changed. The rules files (*.cga) are authored and modified in the Rule Editor which includes scripting editor as well as node-based graphic editor.

```
Footprint -->
    case scope.sz < 10 || scope.sx < 10:
        Extrusion(Eave_Ht,true,1)
    case Building_Form == "setback top":
        SetbackTop
    case Building_Form == "setback facade":
        SetbackFacade
    case Building_Form == "setback base":
        SetbackBase
    case Building_Form == "setback everywhere":
        SetbackAll
    else:
        Extrusion(Eave_Ht,true,1)

SetbackTop -->
    split(x){ 'rand(0.1,0.3): Extrusion(Eave_Ht-rint(rand(3))*Floor_Ht,false,4)
            | ~1            : Extrusion(Eave_Ht,true,6)
            | 'rand(0.1,0.3): Extrusion(Eave_Ht-rint(rand(3))*Floor_Ht,false,4) }

SetbackFacade -->
    split(z){ 'rand(0.03,0.2): Extrusion(Eave_Ht*rand(0.2,0.8),false,2)
            | ~1             : Extrusion(Eave_Ht,true,6)
            | 'rand(0.03,0.2): Extrusion(Eave_Ht*rand(0.2,0.8),false,2) }

SetbackBase -->
    [ extrude(3*Floor_Ht) Mass(false) ]
    t(0,3*Floor_Ht,0)
    split(x){ 'rand(0.6,0.8): Extrusion(Eave_Ht-3*Floor_Ht,true,6) }

SetbackAll -->
    [ extrude(3*Floor_Ht) Mass(false) ]
    t(0,3*Floor_Ht,0)
    set(Eave_Ht,Eave_Ht-3*Floor_Ht)
    split(x){ 'rand(0.6,0.8):
        split(z){ '0.2: Extrusion(Eave_Ht*rand(0.2,0.8),false,2)
                | ~1  : SetbackTop
                | '0.2: Extrusion(Eave_Ht*rand(0.2,0.8),false,2) }
    }
```

Figure 12: Sample rule file editor (Adopted from: Esri's CityEngine Redland Rule file)

In the first step of modelling, the clipped 90m resolution DEM was used as the base terrain. The satellite image was draped over the DEM and used as the base upon which the modelling processes would begin

(Figure 13). Shapefiles of the 2D building footprints, road network, land parcels, zones and building heights were imported into Esri CityEngine for creating 3D visualization while keeping the geographical information from ArcGIS 10.4.1 intact.

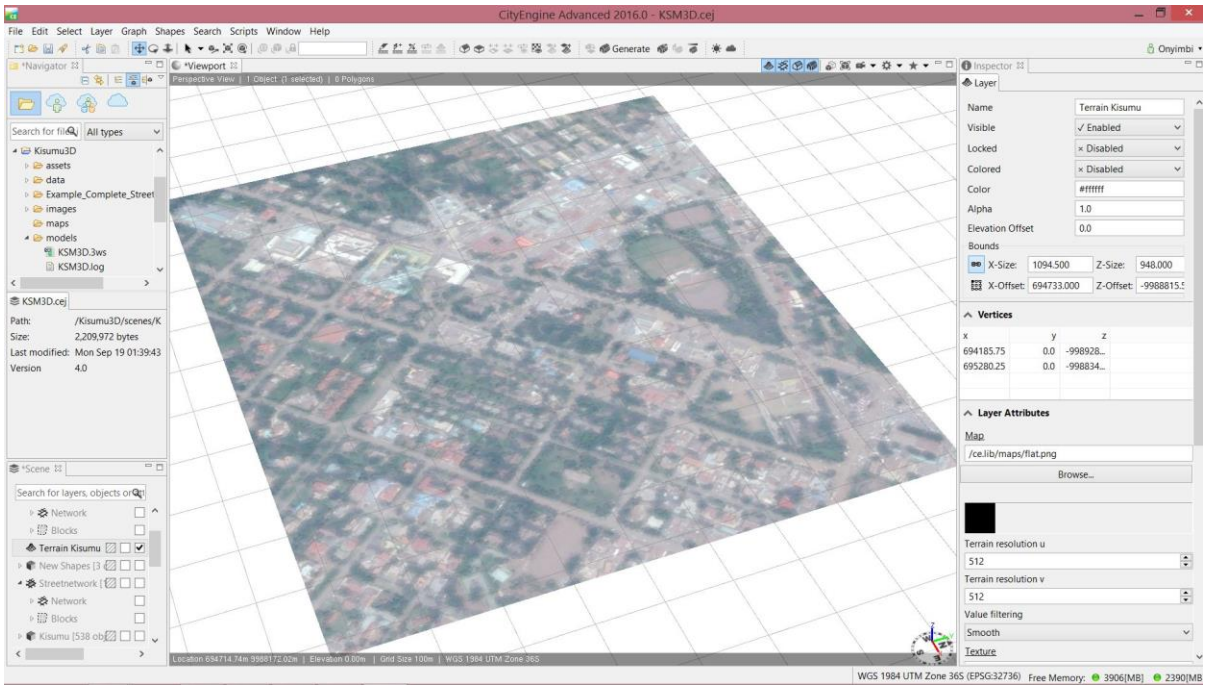

Figure 13: Base Imagery draped on DEM upon which modelling begun (LoD0).

The second step involved the importation, adoption or modification of the rule files to be used in the modelling process. The rule files used were developed by Esri, available by default in CityEngine. Additional rule files were downloaded from Esri ArcGIS online repository (Redlands Redevelopment[7]).

After the generation of rule file, texturing was performed. This was done through the application of the generated rule file to the buildings. LoD2 level model of the buildings was generated by texturing of LoD1 model with the images of buildings obtained from Google Earth to get a realistic view. The observed advantage of rule files was that it enabled texturing with very minimal effort. Texture data (pictures and roof textures) was collected from the Internet and Google Earth. Downloaded pictures were saved in the 'Assets' folder of the CityEngine menu (Annex 2).

The third step was to edit the rules. In total, three rule files were created; buildings, roads, and green areas (trees and grass) rule files. Editing of each rule file was done manually. For example, in building type, building use, roof structure, façade texture, floor height, windows and number of storeys were edited manually for each building.

Through the above steps, all roof and terrain surfaces and texture rules were edited and completed. The next step involved applying the rules and generating the 3D models for the study area. After the model generation, manual modifications and adjustments were done via the inspector window to correct some

[7] *http://www.esri.com/software/cityengine/industries/redlands-redevelopment*

details like widows and storey height (for building), parking type and lanes (for roads), tree types (green areas) among others. Captions of the final model are as shown in the Figure 16 in the results section.

Export and visualization

The aim of this project was to make the model accessible to users via the web. The novel idea was to create an interactive 3D web-based geoportal of the city. However, because of limited time and skills in web development, a cheaper open-source alternative was sought. The idea was to get an alternative that would offer near similar functionalities as had been anticipated. As a result, Esri, through their online hosting services (ArcGIS Online) was used. This site offers both web hosting for the 3D model and navigation through the model while allowing users to view different planning perspectives and scenarios (different layers) and even make comments (opinions and recommendations) online. The scene was generated as a *.cej file and exported as a CityEngine WebScene Model (*.3ws) with a series of ancillary documents. This method does not require users to install CityEngine software, providing a convenient method to promote public participation. The numbered captions of Figure 18 (results section) are images of the area as it is currently and after the proposed redevelopment plans in two scenarios of high density (2a & b) and medium density (3a, b & c) residential development. This gives the users different planning scopes to excite debate, understand the planning project scenarios and express their opinions easily.

One major limitation of ArcGIS online however is the fact that any user must have a user account and be logged in to make and leave comments. Viewing is however public as long as a user is connected to the internet. More so, the creator of the model has no control in terms of giving special permissions or restrictions in levels of access.

Ground truthing.

In the model, building heights were assigned based on the author's local knowledge. This provided room for biases and errors in the estimation of the building heights. To ascertain actual heights, buildings selected for the tasks described in sub-section 3.4.3 were sampled for verification. The actual building height was not measured. However, for each building, heights were physically measured for the ground and first floors respectively. Afterwards, the number of floors per building were counted and multiplied by the floor height.

3.4.3. Group Workshops

The main objective of designing the 3D scene was to test how different users accept, interact and perceive the use of 3D web-based representations against 2D representation. Planning being a participatory processes, it is essential to develop tools that can foster faster understanding and use among different users (Al-Kodmany, 1999, 2001, 2002), while promoting interaction and information exchange (Al-Kodmany, 2001; Simão et al., 2009; Wanarat & Nuanwan, 2013). For this project, three workshops were planned for different groups of participants. However, only two materialised due to disruption of the third workshop by rowdy youths from the community.

Workshops Tasks design and execution.

For all the three workshops, two tasks were designed to assess performance against three laid down criteria: Efficiency (Time taken to accomplish the tasks), Effectiveness (Number of correctly identified objects) and Satisfaction (Opinions of the participants). The tasks were designed to test the participants' spatial orientation of the study area. This was done using 2D maps and the 3D city model in the web-based geoportal. 2D map was used in this case because it is the common format and practise for presenting plans in the city.

In task 1, a list of feature names was presented in numerical order. Ten features were used for this task. On an A3 size paper, the 2D plan showing the plot numbers and road networks for this area was printed and presented to the participants (refer to Annex 10b and 12 in the Appendix). Alongside the 2D map, participants were given a paper containing the numbered list of features. Each participant was required to get a name of a feature from the provided list and then using their spatial knowledge of the city, locate the feature in the provided 2D map. Upon locating a feature, each participant was expected to indicate on the 2D map the number corresponding to the name on the list provided. This task was performed in 10 minutes, after which all the maps were collected for further analysis.

Task 2 involved the use of the 3D city model in the web-based geoportal. In a similar format as Task 1, features were marked with letters A-J on the geoportal. A sheet of paper with the letters A-J was also provided to each participant (Annex 10a in the Appendix). The task required each participant to identify a feature marked by a letter on the 3D city model in the web-based geoportal and write the name against the corresponding letter on the sheet of paper provided. This task was also timed for 10 minutes.

The features selected were based on their prominence in the city in terms of them being public buildings or space or have outstanding structural features like heights. Before the commencements of the tasks, all participants confirmed their strong understanding and knowledge of the city scape and therefore identifying features would not pose any challenge.

Finally, the proposed redevelopment area was presented to the participants in the 3D web-based geoportal. The proposed redevelopment scenarios were exported into the web geoportal as separate layers. Participants were asked to navigate through, compare and analyse the layers of the areas as it is and the two proposed redevelopment scenario layers. Later, a questionnaire was administered at the end of all the tasks and a short general discussion thereafter to find out participants perceptions.

The 10 minutes task time was set after conducting independent tests during pre-fieldwork phase with four different people. The time taken to complete the tasks was then averaged as shown in Table 5.

Table 5: Results from test-run of the tasks

	Time (Minutes) to accomplish task		
Person	Task 1	Task 2	Average
1	12.05	8.10	10.07
2	10.20	8.58	9.39
3	12.00	8.42	10.21
4	10.55	11.00	10.77
Average	11.20	9.02	10.11

The results from the tasks, questionnaire and the discussion thereafter were analysed for purposes of this research and are presented in the results section.

Workshop Organization.

During the workshops, a web link (http://arcg.is/2k68mrQ) was sent to each participant to open the 3D model in the web geoportal. This required stable internet connectivity. Each participant was expected to perform the described tasks independently. The author and two research assistants controlled the environment, issuing task materials, guiding layer navigation and monitoring time. At the same time, they guided the discussion thereafter.

The first workshop was for students from the school of planning and architecture, Maseno University. The second workshop was for professionals who included practising physical planners (5), Architects (3), Surveyors (5), Civil Engineers (2) and others (4). The professionals were chosen since they deal and interact with spatial matters in most of their daily work. The third workshop was intended for the general public, but did not take off.

The tasks were organized as a comparative test in two dimensions: comparing the usability of 2D against 3D presentation of planning projects.

Feedback

Output of the workshop exercises was generated through the tasks performed, the questionnaires filled and the discussions thereafter. The author similarly used observation as a method to deduce some useful information from the way participants acted and reacted while using both the 2D and 3D presentations. This formed an equally important facet in the analysis of perceptions of the participants.

Challenges and limitation

During the workshop tasks, a web link was sent to each participant to access the geoportal. This required stable internet connectivity due to the size of the file. During all the FGD tasks, two limitations sufficed. Due to poor internet connectivity of the venues (GIS Lab of Maseno University and the Community Hall), the 3D scene was not able to load. However, a portable Wi-Fi flybox was used instead to provide connectivity. Secondly, the interactive section of the online portal is only available to registered users. As a remedy, one user's account was used to log in to all the other computers. This consumed a lot of time

considering the low rate of upload of the scene due to slow connectivity. In the GIS lab of Maseno University, we successfully had access to and loaded the scene to only 6 computers. Every computer thus had 3 participants as users (example in Figure 14). However, the tasks were completed on individual basis. This increased biases since it was hard to tell whether the completion of a task was joint effort or an individual's.

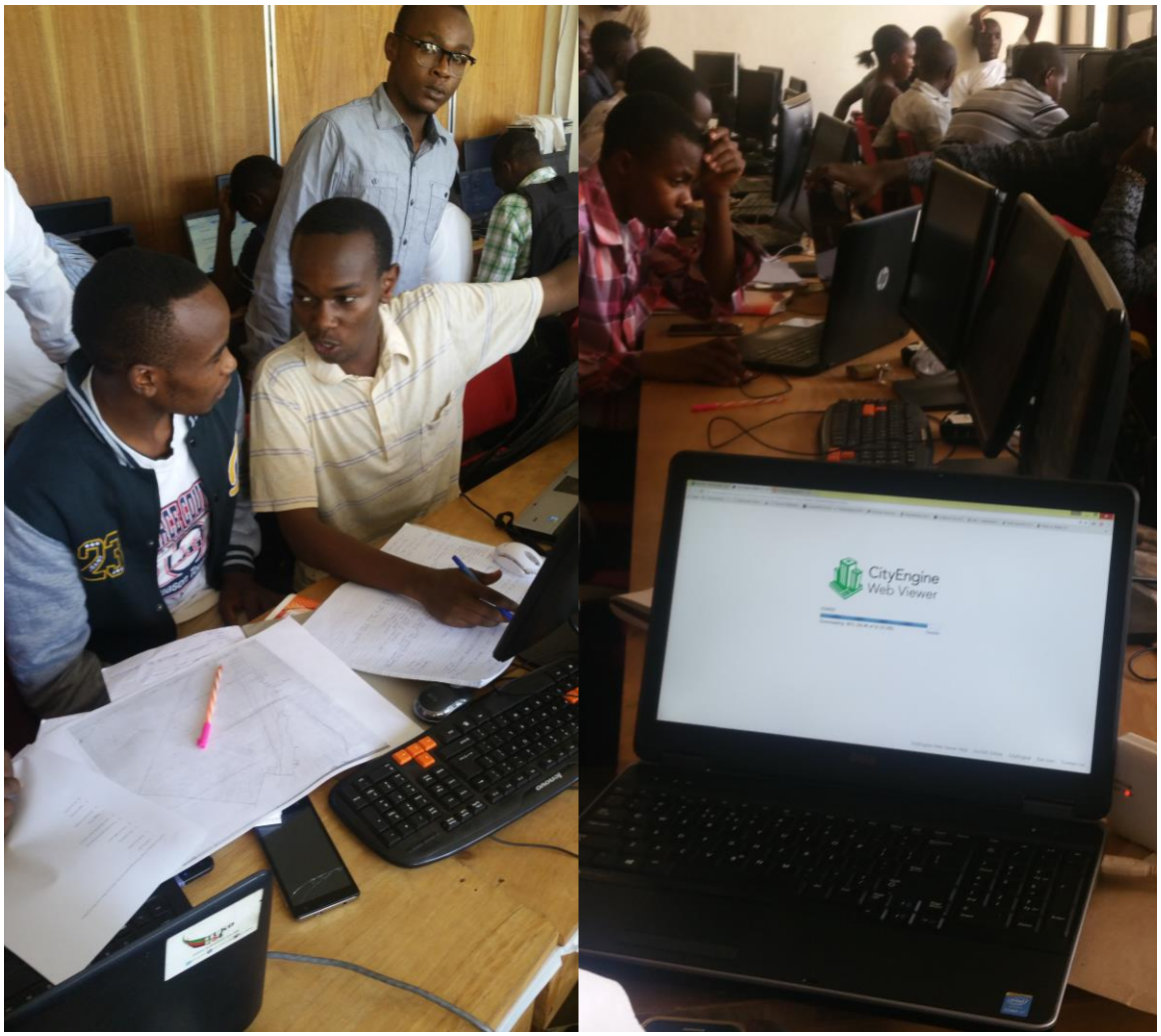

Figure 14: Workshop session (left) and the web scene loading (right)

3.4.4. Field survey

Field survey involved further data collection through the administration of questionnaires and key informant interviews. A mixed method approach was used in this survey, incorporating the collection and analysis of both qualitative and quantitative data.

Household Interviews

For purposiveness and representativeness, a mix of purposive and snowball sampling was used and a sample frame and size defined. All ethical considerations (confidentiality, informed consent, no harm, non-coerced response, privacy and honesty) were taken into consideration. Collected data was entered into SPSS at the end of each day. A total of 78 residents were interviewed. The results of the survey and analysis are presented in section 4.

This was carried out to gain a general insight into the professional planners' perspective of the use of E-participation and 3D visualization in planning processes in the country in general and Kisumu city in particular. Particular emphasis was put on comparing the use of 2D versus 3D representations and traditional (paper adverts and notices) versus digital ways (E-participation) of inviting and conducting public participation exercises. The survey questionnaire (attached as Annex 9 in Appendix) was sent via email and other social media to practising professional planners. A total of 300 questionnaires were sent. However only 207 questionnaires were filled and returned.

3.4.5. Key informants

To realise objectives 1 and 2, key informants were interviewed. These included a city planning officer, the dean school of planning and architecture, Maseno University, a County Architect, a private physical planner and an NGO project manager. The list of the key informants and interview dates/time are presented in the Appendix section as Annex 11. Questions were sought as how the county government carries out the business of planning and what the perception of the general public and the consumers of planning services are towards planning. The interviews were guided by a set of questions (Annex 6) and responses recorded on the question sheet, analysis of which are presented in the results section 4. Not any informant agreed to have the conversation recorded live for fear of *'victimization'*[8].

3.5. Conclusion.

The methodology used in this study was implemented in a way to perform a comparative analysis in two aspects. First, based on the understanding that planning instruments must be presented to stakeholders, the study sought to establish the perception of users in regard to 2D presentations (which is the commonly used method presently) on the one hand and presentation of same scene in 3D on the other. Secondly, the study sought to find out the different methods used to invite public participation on the one hand and the degree to which new technological fronts specifically electronic, can be used in inviting public participation. The comparison was on the public preferences in regard to the methods presently used and the electronic methods available. Despite major challenges as highlighted in the limitations sub-section, the study was carried out successfully.

[8] *Common reason provided by all the respondents when asked why they feared being recorded.*

4. RESULTS AND DISCUSSION.

4.1. Introduction.

This section presents the study findings and interpretations thereafter. First, the results are presented in the order of the study objectives. This is followed by the discussion sub-section which gives an insight into the connection between the findings and the study objectives.

4.2. Results.

The processing and analysis performed on the available and collected data produced different results. Different sets of datasets were processed and analysed differently depending on the objectives and questions to be answered. These are presented in herein.

4.2.1. Questionnaire return rate.

For the general survey, a total of 300 questionnaires were dispatched to planners via email and other social media channels. From the 300 dispatched questionnaires, 207 were filled and returned giving a response rate of 69.0%. However, some questionnaires had mandatory questions unanswered. Only a total of 185 questionnaires were fully answered. From the workshops, a total of 38 questionnaires were given out, all filled and returned while for the household survey, only 78 out of the 90 printed questionnaires were correctly filled and returned. Table 6 shows the response return rate for the study. From the Table 6, the percentage return rate was (38/38) × 100 = 100.0%, (78/90) x 100 = 86.7% and (207/300) x 100 = 69.0% for the workshop, household and general surveys respectively. According to Fincham (2008) and Glaser (2008), acceptable response rates vary by how the survey is conducted. For Mail 60-70% very good, Phone 70-80%, Email: 40-60%, Online: 30% average and Face-to-face: 80-85% response rates are acceptable. Therefore, the return rates presented in Table 6 were appropriate for data analysis and discussion for this study.

Table 6: Study Questionnaire return rate

Category	**Issued**	**Filled and returned**	**Valid**	**Return rate**
Workshops	38	38	38	100.0%
Household	90	78	78	86.7%
General	300	207	185	69.0%
Total	428	323	301	70.3%

4.2.2. Objective 1: Existing methods of inviting public participation.

The results contained in this section were obtained majorly from key informant interviews and surveys. The methods used to invite and engage the public to a great extent influence the rate of participation in

any planning process. Furthermore, different legislation, factors and actors may dictate what types of methods are used to invite and engage the public in planning processes.

Current planning practise and the legal framework

The core principle of public participation is that those who are directly or indirectly affected by a decision have a right to be involved in the decision-making process and that their contribution will influence the final decision. This is anchored in Article 10 of the Kenyan Constitution which defines public participation as a national value and principle of governance where the people's sovereign power can be expressed through direct participation or indirectly via elected representatives (GOK, 2010). Different Acts also imbue public participation in the decision making processes. Examples include the County Governments Act, the Urban Areas and Cities Act 2011, Environment Management and Coordination Act 1999, the Lands Act 2012 among others. Moreover, the local authorities, through various city-specific by-laws, exercises development control as provided for in the constitution.

For development plans prepared by the director (national, regional and some local plans), public participation is usually invited via the Kenyan Gazette where the Director publishes such notices. The director may also publish the same notices on any local dailies. Likewise, any local authority, with the approval of the director, may also publish in a local their intention to plan an area within their jurisdiction. Noteworthy is that for this type of plans, the public is only invited to make comments on or objections to the plan already prepared by the director or the representative local authority, example as shown in Figure 15. How these comments or objections are documented and treated thereafter remains unclear as one city official observed;

'…We usually publish these notices in the Daily Nation and the Standard Newspaper. I am not aware of and therefore cannot provide you with any records kept in our office of comments or objections received since I started working here in 2008, but I know some case are in court which I will not comment on...' (Key Informant 1, listed in Annex 12, Appendix)

In some case, local authorities organize community consultative meetings to discuss proposed planning. From the study, two key issues emerged. First, alongside the advertisements, the local authority uses ward administrators who are employees of the county government to disseminate invitation to participate to the general public. Secondly, ward administrators in turn use local community leaders to disseminate this information to the general public. From the public however, the general concern about this mode of inviting the public to participate is that it is open to abuse and biases by those charged with the task of inviting residents. The ward administrator in most cases invites only community leaders considered 'friendly'[9] to the administration of the day. Similarly, community leaders tend to invite their 'friends and relatives'[10] so as to benefit from cash incentives offered.

[9] *Sentiment from most interviewees during the household survey, derived from questions on reason of their choices of communication mode.*

[10] *Sentiment from most interviewees during the household survey, derived from questions on reason of their choices of communication mode.*

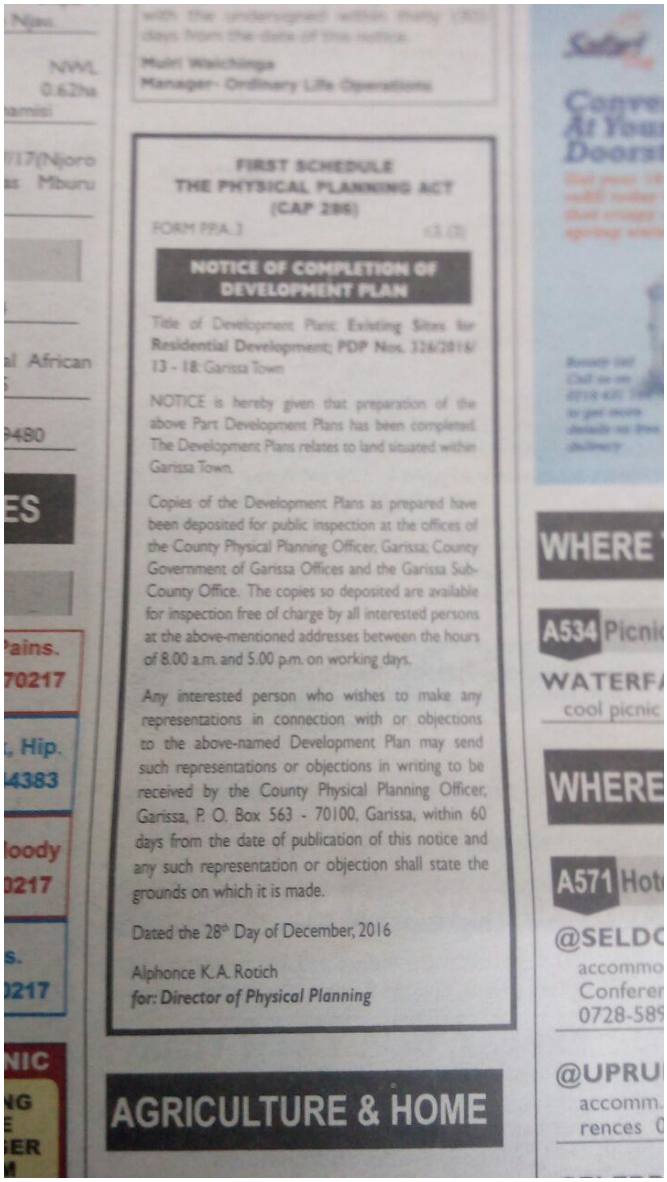

Figure 15: Example of a Planning Notice in a local Newspaper:- the public is invited to make 'representations in connection with or objections to the plan...'

From the analysis of the results, the salient communication mediums commonly used are as shown in Table 7, depending on the spatial scope of the plans prepared.

It was somehow unanimous, both from reviewed literature and the household surveys, that in most planning cases, the general public is often involved in the very last stages of the planning process, that of viewing the plans and making comments or objections. From the interviews, it was somehow hard for the local authority officials to explicitly point out at what stages they often involve the public. Moreover, there were no records kept to this effect at the local authority planning office.

Table 7: Categories of Plans and Methods of Inviting Public Participation.

Category	**Initiator**	**Approval**	**Medium**	**Source**		
				LR	**SR**	**KII**

National Spatial Development Plan	Director[11]	Director	Kenya Gazette, At least 2 local Dailies	√		√
Regional Spatial Development Plan	Director	Director	Kenya Gazette, At least 2 local Dailies	√		√
Special Area Development Plan	Director/LA	Director	Kenya Gazette, At least 2 local Dailies, LA Notice Boards	√		√
Development Control (Building permits, Change of use, Extension of lease, Subdivision, Amalgamation)	LA	LA	Local Dailies, On-site notice, Verbal (community leaders, friends)	√	√	√
LR: Literature review, **SR**: Survey Respondents, **KII**: Key Informant Interviews, **LA**: Local Authority						

The results presented in this objective passively but strongly points to the role of politics in planning. Politics plays a major role in influencing the type of method used to invite the public to participate. Planning being a political tool in the country, politicians often prefer methods that would ensure they manipulate the process and select only their supporters as participants at the expense of 'opponents'[12]. The concern that invitations may be favourable to the sections or people in the community friendlier to the administration of the day and politicians indicate the strong degree of influence politics has on participation in planning processes in the city.

4.2.3. Objective 2: Levels of public participation

Kisumu has experienced significant changes in spatial development since the inception of the new devolved system of governance in 2013. There has been a big focus on real estate development, encompassing the establishment of new or refurbishment of old commercial and residential developments. The CBD and its surroundings account for 30% of these changes (ASDSP, 2016), with the conversion of old residential buildings into new high-rise office spaces, conversation of two - three storey buildings into multiple high-rise storeys.

One particular area that the local government has shifted focus to is the provision of decent but affordable housing to match the growing population. Various projects have been undertaken, but mainly by private developers (individuals) and housing corporations. The Local Authority, through one of its agencies, Kisumu Urban Projects (KUP) has proposed to construct medium density 4-storey residential units on north eastern parts of block 7. According to key Informant 1, the project was designed, drawn and advertised in the local dailies as required by law. However, no official was willing to disclose the contents of the plan or provide the actual building plans. Moreover, even though the interviewee claimed that the public was called for a public forum to discuss the plan, there was no data or records shown to prove this.

The unavailability of records on public participation for the redevelopment project from the LA informed the need to carry out a survey. The survey was carried out among residents on their knowledge about the

[11] *Director, Physical Planning*

[12] *One participant's observation during the interview.*

proposed redevelopment and if they participated in the process. Only respondents who were above the age of 18 and heads of the households were interviewed. From the interviews, 32.1% (25 out of 78) of the respondents were aware of the planned redevelopment of their neighbourhood. We did not however establish how they became aware of the proposed plan.

Table 8: Awareness of the redevelopment plan (Left) and Number of those who received invitation to participate (Right)

		Frequency	Percent	Valid Percent		Frequency	Percent	Valid Percent
Valid	Yes	25	32.1	32.1	Yes	11	44.0	44.0
	No	53	67.9	67.9	No	14	56.0	56.0
	Total	78	78.0	100.0	Total	25	100.0	100.0

From Table 8, 44% of those who were aware of the redevelopment (right section) received invitation to participate in the planning workshop organised by the local authority. More than half of those who were aware of the project (56%) had not been invited to participate in the process. Verbal invitation from community leaders (73%) was the major media used to invite members to participate in the planning process. Others read the invitation from print media (9%), public notice boards and electronic media (specifically radio) as shown in Figure 16.

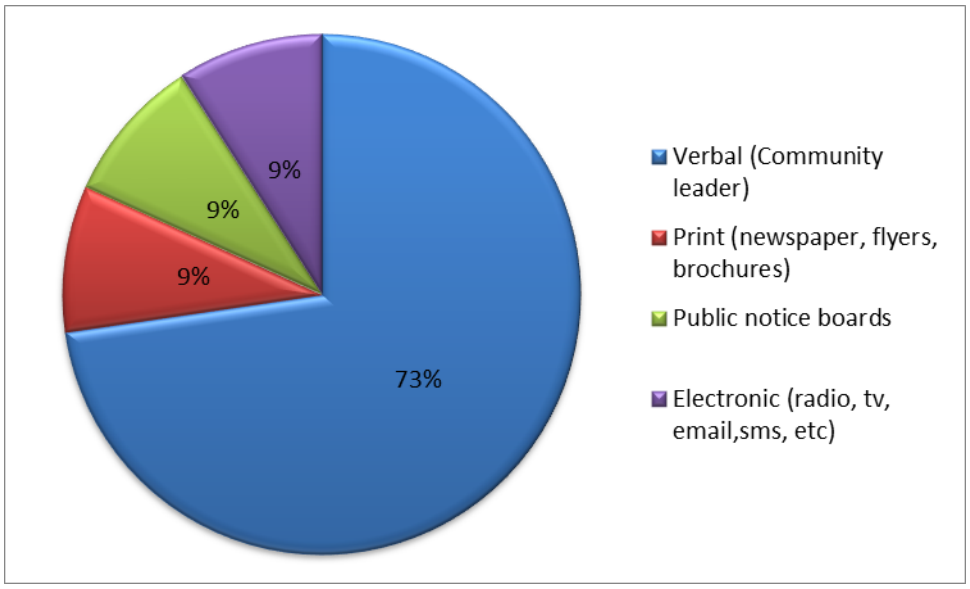

Figure 16: Channels through which participants received invitation to participate in the planning workshop

The attendance rate was significantly high, with 81% of those who received invitation attending the meeting (Table 9). This shows high degree of willingness to participate from the residents. This is expounded in the discussion sub-section 4.4.

Table 9: Percentage attendance of invitees to the planning meetings

		Frequency	Valid Percent
Valid	Yes	9	81.8
	No	2	18.2
	Total	11	100.0

When asked if they felt their views were taken into consideration during the participation process, 54.5% of the interviewees felt that even though they were given equal opportunities to participate during the meetings, their views may not be considered in the final decision making.

Table 10: Participants response to question 13:-Your views were taken into consideration in the process

		Frequency	Valid Percent
Valid	Very true	1	9.1
	True	2	18.2
	Not true	6	54.5
	Don't know	2	18.2
	Total	11	100.0

Information deduced from the interviews pointed to various factors influencing the choice of methods used to invite the public to participate in planning processes. These factors determining choice of medium to invite public participation and methods used are summarised as shown in Table 11.

Table 11: Factors determining choice of methods of invitation to and conducting public participation

Factors	Social	Economic	Governance
Indicators	✓ Social Networks ✓ Social Inclusion ✓ Education Level	✓ Income Level ✓ Employment status ✓ Financial Viability	✓ Transparency and accountability ✓ Monitoring and evaluation ✓ Politics ✓ Enabling environment

The absence of records of public participation and the proposed plans from the local authority made it difficult to compare the results from the surveys with the local authority's data. The availability of the proposed plans and data on number of participants and their roles would have formed a good basis to evaluate the levels of public participation attained in this project. This informed the choice of the comparative method in this study where the area is evaluated based on its present form and an imagined design. The results presented in sub section 4.2.3 are therefore based only on the household and the general surveys carried out. Nonetheless, the results also compare to observation made by some respondents in objective one that invitation by community leaders may be open to bias. Invitation by community leaders was the major way the participants were invited. With only 11 out of 78 participants receiving invitation to participate, it indicates a probability of the invitation not being sufficiently distributed to the populace or the preferential dissemination observed earlier.

4.2.4. Objective 3: 3D modelling and visualization.

Data

Different types of literature provided insight into the kinds and types of data required for the modelling processes as presented in Table 12. After careful review, RBM was selected since the data available and the software package (CityEngine) supported it.

Table 12: Data requirements for 3D modelling

Data Type	Format	Attributes	Use	Source
Building footprints	shapefile	Area, Setback,	Extrusion to 3D	Local Authority, online open source repositories
Parcel Boundaries	shapefile	Area,	Defining setbacks, plot ratio, green garden, footpaths etc.	Local Authority
Transport Network	shapefile	Names, Class, Length, Objects	Determine mobility, draw a pattern of development.	Local Authority, OpenStreetMap
Building Heights	shapefile	Height	Extrude BF in positive vertical dimension	Local Authority, Automatic height Extraction.
Building purpose/use	shapefile	Use, purpose, floors etc.	Defining space and usage rules	Local Authority
Zoning Plan	shapefile	Zones, Uses, Densities, Restrictions	defining restrictions, guiding future development, ensuring complementarity of uses	Local Authority
DEM (90m)	Tiff/img/jpg	Elevation (ASL, resolution)	setting modelling terrain, position various objects , draping.	SRTM, other commercial sources
Ground cover	shapefile	Ground cover type, area.	Represent open spaces for a realistic look.	Satellite Images, Local Authority.
Satellite Image (0.5m)	Tiff/img/jpg	Resolution, Extent	Draping with DEM, Auto-extraction of heights (stereo-pair)	Commercial providers

Modelling methods, standards and software

Two broad modelling methods were reviewed in this process; Image Based and Rule Based modelling respectively. RBM was selected due to its flexible ability to model and modify structures using simple rules. The modelling was done within the confines of CityGML standards defined by ISO. An array of softwares were available, both open source and commercial including Sketchup, ArcScene, QGIS, CityEngine among many more. CityEngine was chosen for its ability to export 3D models as a webscene. This enabled the visualization of the model in an online portal provided by ArcGis.com.

Visualization and presentation

Various options were looked at. The objective of the visualization was to present the model in a way users would be able to navigate through and interact with its various features.

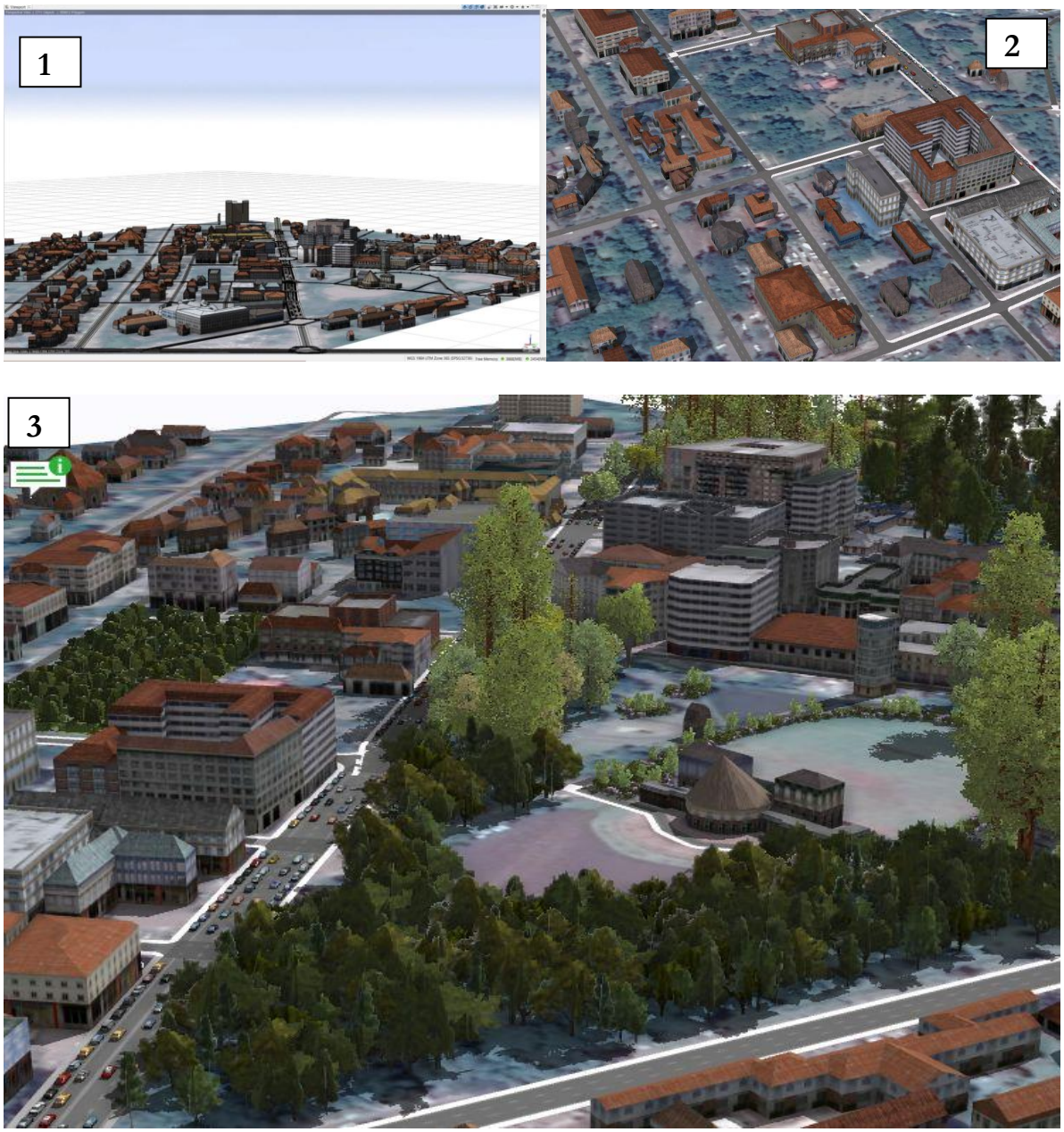

Figure 17: Captions of parts of the 3D city model of Kisumu.

Therefore, the development of a 3D web geo-portal was considered, offering possibilities of online interaction and feedback mechanism. Due to limitations in programming skills, it was not possible to develop a full stand-alone 3D web geoportal. The Figure 17 shows the various captions of the final model, with part 3 showing a comment left by a user about a particular building, while Figure 18 shows the redevelopment area in its current state (1), Scenario 1 (2 a&b) and Scenario 2 (3 a, b&c).

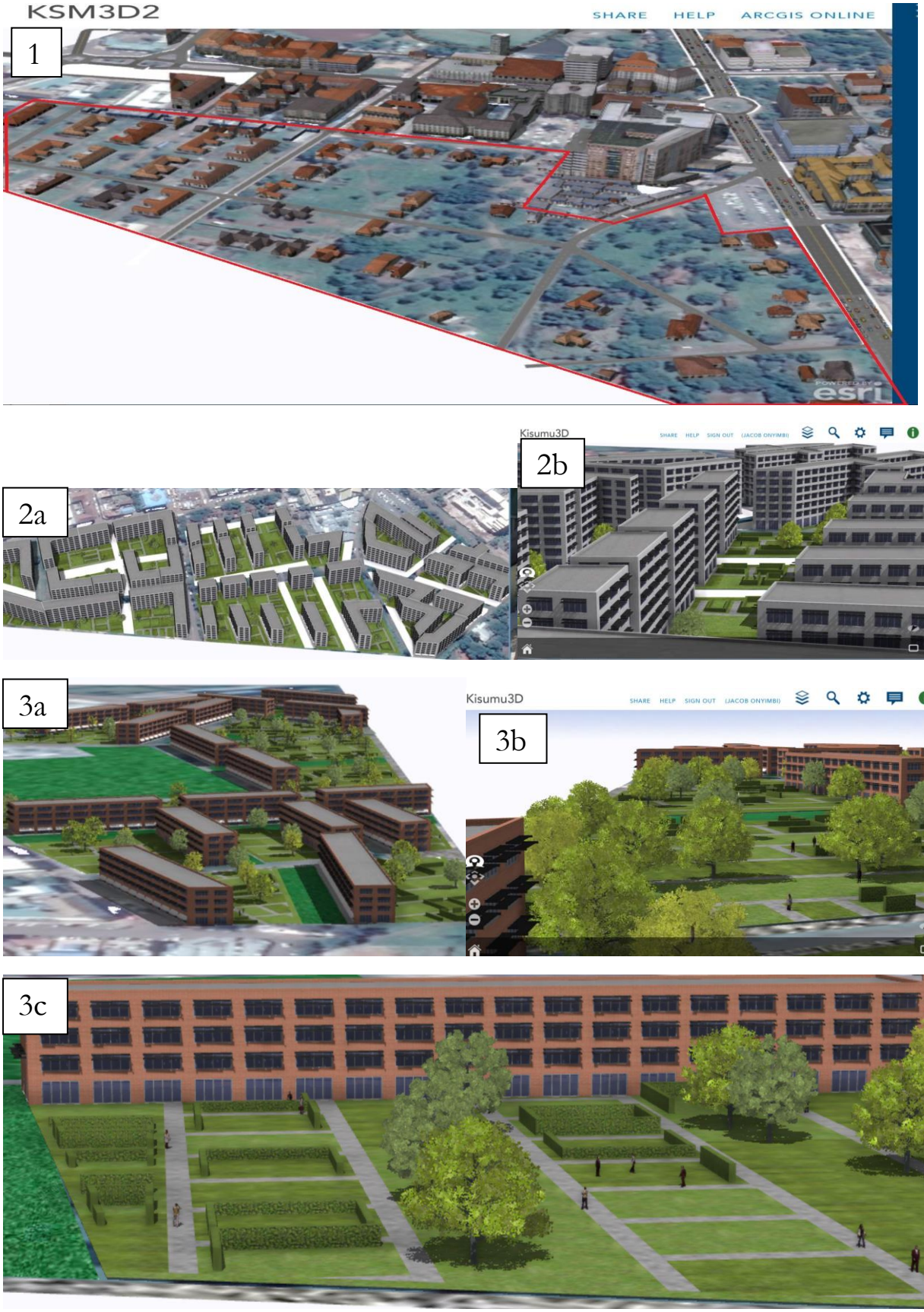

Figure 18: Redevelopment Area: 1- Current state, 2-Scenario 1 High density, and 3-Scenario 2 Medium density

The modelling process involved developing new or modifying existing rule sets. When the model was exported into ArcGIS online web portal, a user or a creator of the 3D model had no control and

restriction (like level of access) on the geoportal. To create a stand-alone 3D web geoportal and export the 3D model into it requires advanced web development and programming skills. Due to time limitations and inadequate skills in programming and web development, it was not possible to create a geoportal. However, ArcGIS online provided a solution even though it had significant limitations in as far as use and interaction with the model is concerned.

4.2.5. Objective 4: Impact of 3D and E-participation on public participation.

The guiding question for this objective was to establish to what extent the integration of 3D model visualization as a Planning Support (PS) tool and E-participation would impact public participation in planning in Kisumu city. The process was carried out in a controlled experiment described in section 3.4.3 in a bid to test three basic aspects of added value, that is, usability (Effectiveness, Efficiency and Satisfaction), communicative and collaborative abilities as well as learning aspect of a PS tool.

Every indicator was tested using a particular set of tasks while satisfaction was derived from responses in the questionnaires administered thereafter. The communicative, collaborative and learning aspects were analysed from the observations and questionnaire responses received.

Effectiveness

Effectiveness was tested on the basis of the number of correct answers given within the set timeline. Each professional group showed different characteristics as shown in Figure 19 below.

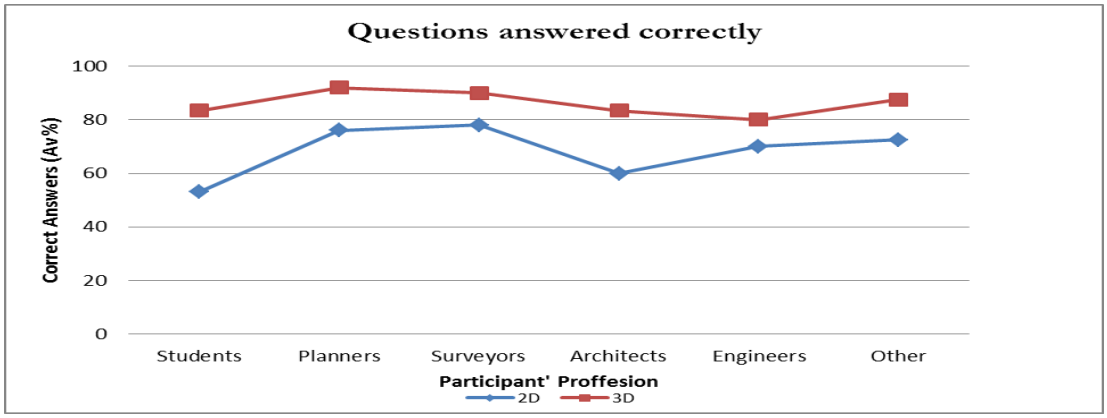

Figure 19: Percentage correct answers categorised per profession.

Generally, the entire professional groups answered more correct answers in the 3D task as compared to the 2D task. Students performed fairly low in the 2D task (53%), while engineers performed low in the 3D task. Engineers and surveyors however had very minimal difference in the number of correctly answered questions in 2D and 3D tasks. The correlation is further discussed in section 4.3.

Efficiency - Time bar analysis by profession.

Efficiency measured the effectiveness in respect of time spent to answer the questions. Planners took shorter time average in answering questions related to 3D than 2D while the student group took the longest times (12) for both 2 and 3D tasks (Figure 20). On average, no particular group managed to get all the correct answers in the specified time.

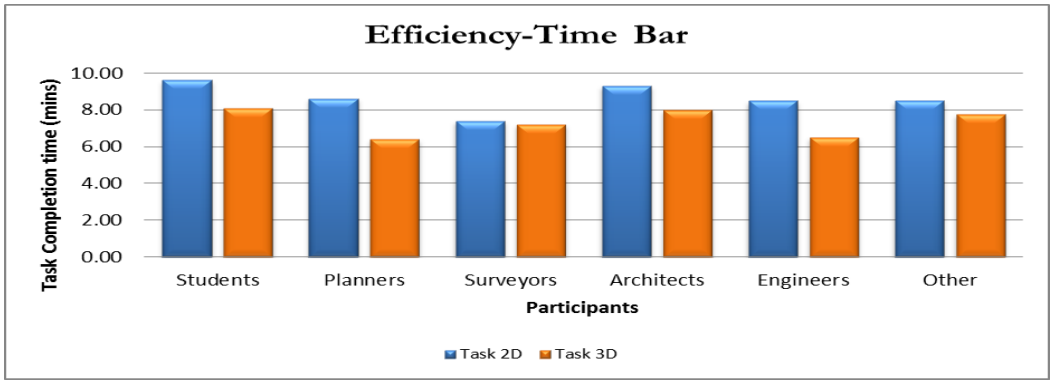

Figure 20: Task completion time per participant's group.

Satisfaction

Responses from the questionnaire pointed to a likely preference for 3D over 2D where 83% of the 37 respondents preferred the use of 3D over 2D (Table 13) citing varying reasons, explained in section 4.3.

Table 13: Participants' preference arising from usage satisfaction of 2 and 3D representations.

Consider3D_over2D				
		Frequency	Percent	Valid Percent
Valid	Yes	31	83.8	83.8
	No	6	16.2	16.2
	Total	37	100.0	100.0

Learning: Processes and Outcomes

Learning was evaluated based on the participant's perception on the tool's ability to improve their understanding and knowledge of the planning scenario(s) and the thought-changing process triggered by the by the PS tool presented.

From Table 14, 81% of the respondents (32.4% Agree and 48.6% strongly Agree) indicated that the PS tool presentation had improved their understanding of the plan and the area, as opposed to 56.7% indicating that their understanding improved when 2D presentation was used.

Table 14: Comparative learning tables through use of 3D and 2D representations.

		Improved_understanding3D		Improved_understanding2D	
		Frequency	Valid Percent	Frequency	Valid Percent
Valid	Strongly disagree	1	2.7	1	2.7
	Disagree	3	8.1	7	18.9
	Not sure	3	8.1	8	21.6
	Agree	12	32.4	14	37.8
	Strongly agree	18	48.6	7	18.9
	Total	**37**	100.0	**37**	100.0

Moreover, Over 85% of the respondents observed that the 3D presentations were easier to understand than 2D as opposed to the 32.4% who indicated that the 2D representation was easier to understand than 3D as shown in Table 15.

Table 15: Participant's perception on level of understanding of 3D and 2D representations.

Easy_understand3D					Easy_understand2D		
		Frequency	Percent	Valid Percent		Frequency	Valid Percent
Valid	Disagree	1	2.7	2.7	Strongly disagree	10	27.0
	Not sure	4	10.8	10.8	Disagree	13	35.1
	Agree	9	24.3	24.3	Not sure	2	5.4
	Strongly agree	23	62.2	62.2	Agree	11	29.7
	Total	37	100.0	100.0	Strongly agree	1	2.7

Communication and collaboration

The communicative ability of this tool was evaluated based on its flexibility and the ability to convey information that triggers a change of thought of the participant. While 35.1% agreed that 2D representation was more flexible to deal with and manipulate, 89.2% were of the opinion that 3D representation was more flexible to deal with than 2D (Figure 21).

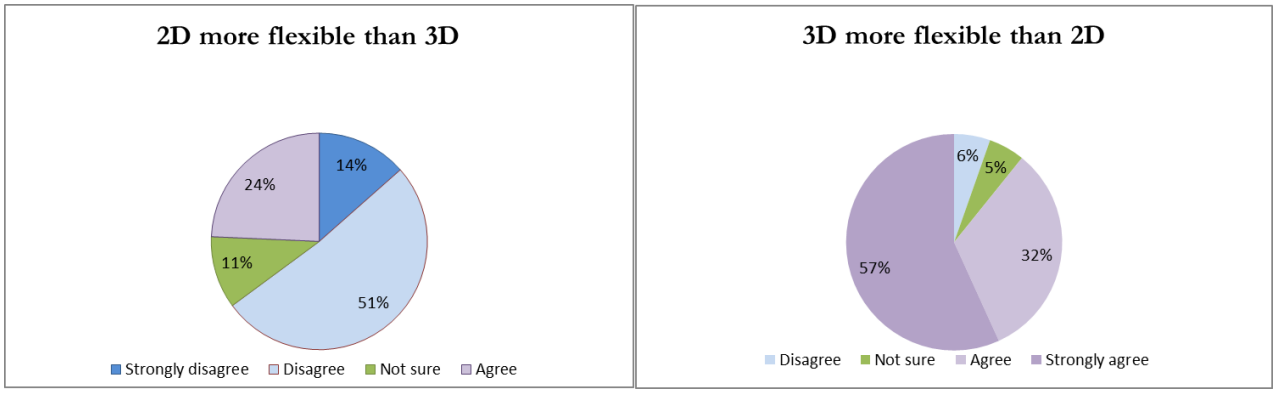

Figure 21: User perceptions on flexibility of the different methods presented

A similar trend was observed portrayed in Table 16 where 83.8% observed that the information content conveyed by use of 3D representation made them change their thoughts of how plans and scenarios were presented.

Table 16: 3D enabled learning and change of thought

Learning_changedthought_3D				
		Frequency	Percent	Valid Percent
Valid	Disagree	3	8.1	8.1
	Not sure	3	8.1	8.1
	Agree	11	29.7	29.7
	Strongly agree	20	54.1	54.1
	Total	37	100.0	100.0

The presentation of the 3D model in the online geoportal enabled multiple users to access it simultaneously. The possibility for different users to navigate through the scenes and more so, evaluate and comment on features of interest has the potential for promoting collaboration and information exchange between various stakeholders. The online portal presented a forum through which different stakeholders could provide their views and also read views from other stakeholders. As opposed to public meetings where the choice of a speaker is dictated by the moderator, this method at least guarantees that every member with access to the portal can comment if he/she so wishes to.

E-participation

Due to the limitations and challenges posed by the web portal mentioned in sub section 4.2.4, it was somehow difficult to carry out a substantive evaluation of the E-participation capabilities of the tool Nonetheless, the possibility of users commenting and being able to read other users' comments provided one front for evaluation. The main goal of E-participation is to ensure good access to the tool by all users and the possibility to 'participate' at any time or from any location, anonymously or not. The 3D web-based geoportal made this participation possible. The participants were able to view and navigate through the different objects in the model, and even leave comments, particularly on the redevelopment area.

Results from key informant interviews pointed to the interviewee's preference for E-participation methods, especially SMSs/USSDs and emails. Some indicated that it would be good if the county government digitized all its operations, noting that this would ease work and eliminate 'corruption cartels' in the county government.

"I think the best method would be to create a website where the public can view and comment on issues anonymously, and even submit their development proposals. In this way, we will cut down on delay bureaucracies and seal loopholes that some corruption cartels use to steal from the public and the county government". Key Informant 3

From the general survey carried out among practising planners, a larger percentage indicated their awareness and use of E-participation, especially use of SMS. We did not however establish where they had used these methods. From the results, it was evident that most planners preferred e-participation channels as opposed to the traditional city-hall planning meetings and workshops. Reasons cited for their preference included time and cost saving, convenient, no victimization, participation independent of space and time of day, ability to bring more participants on board, some degree of transparency, audit trail (accountability) among others. Further, different channels of e-participation for inviting and engaging the public scored different approvals from the survey respondents. The Table 17 summarises the scores for the different channels.

Table 17: Modal preference for inviting and engaging public participation.

Category/	Very Satisfied	Somewhat Satisfied	Satisfied	Least Satisfied	Not Satisfied	Dissatisfied	Don't Know	Total
SMS/USSD	130 (70%)	45 (25%)	95%	2 (1%)	0	1%	8 (4%)	185
E-mails	44 (24%)	60 (32%)	56 %	43 (23%)	35 (19%)	42%	3 (2%)	185

Online forum	50 (27%)	78 (42%)	69%	42 (23%)	11 (6%)	29%	4 (2%)	185
SmartApps	10 (6%)	41 (22%)	28%	59 (32%)	58 (31%)	63%	17 (9%)	185
No. of Participant: 130=Absolute, (70%)=Percentage								
Satisfied= (VS+ SS) Dissatisfied= (LS+NS)								

From Table 17, it is seen that SMS/USSDs have a higher preference rate followed by online forums and emails respectively. The argument of most respondents was that mobile phones have a high penetration rate even among the lower classes of the population. As such, information exchange is likely to be within a larger population size, as long as one owns a mobile phone. This explains the dip in smartphone apps with most respondents indicating that smartphones are still not very affordable to most of the population, especially the poor. The argument for emails and online forums was that as opposed to the cost implications in smartphones, emails and internet services can be accessed from cyber cafes even where a citizen does not own a personal computer.

In summary, the 3D web-based geoportal used as a planning support tool has shown that it has varying impacts based on the indicators used to evaluate it. For this study, five indicators were selected. When the tool was tested with different users, the different professional groups exhibited varying characteristics with the use of the tool. From the results therefore, it is seen that both 3D visualization and e-participation have impacts on public participation. However, it is important to point out that the use of these tools is context-specific and the results may vary in different set-ups. The design of tasks and the methodology may also influence the results

4.3. Discussion

The results presented in section 4.2 revealed useful insights into the characteristics of the participants and their use of both 2D and 3D representations of the geographic space and scenarios. It also pointed to how the integration of a PSS tool, in this case a 3D model in a web-based geoportal, with other E-participation methods can impact public participation in planning processes.

Under the old constitution, planning was mainly governed by the Physical Planning Act (PPA CAP 286) of 1996. However, debates were rife on the conflicting provisions and grey areas in other land related regulations, and the need to have a unified but comprehensive legislation to govern the utilization and management of land, both rural and urban. For example, the Land Control Act (LCA) which regulates the development, use and subdivision of agricultural land, was designed to ensure that agricultural land is used and developed in such a way that good husbandry is not compromised. There was established a Land Control Boards, the body mandated by the LCA to ensure that the prospective user is capable of putting the land to productive agricultural use and that the land is not subdivided into sizes which are not capable of being put into agricultural use (KLRC, 2011). However, LCBs drifted away from monitoring agricultural use and became a body for promoting family peace i.e. ensuring that the family is in

agreement on whether to sell the land or not. The role of controlling the subdivisions is therefore left in the hands of the local authorities.

The new Kenya constitution of 2010 set a new framework of governance that sought to devolve development and power to the people of Kenya by establishing 47 counties which serve as the basis for national governance and planning. The Constitution of Kenya in general and the PPA Act in particular provides for public participation. The rationale behind the promotion of public participation is to promote the utilization of local knowledge and resources and to encourage transparency and accountability in processes of public interest (GOK, 2010). The argument being that citizens should not only have access to information but must also be entitled to participate in decision-making and have access to justice (Okello et al., 2012).

The literature reviews and surveys carried out indicated that in general Kenya has relevant constitutional provisions regarding public participation. However, the various legislations do not explicitly define who the public is, what public participation itself is and stages of engaging public participation in planning processes. This makes it hard to determine if the prerequisites of public participation as defined in the legal frameworks have fulfilled the obligation to ensure effective public participation, as noted by Okello et al. (2012). There is also poor access to information, even though the public has considerable interest and willing to participate in planning activities that affect them.

Newspapers form the biggest media through which public participation is invited. But the low level of newspaper circulation at 6 newspapers per 1000 people (1.3%) (Obonyo, 2010) makes information contained in these papers inaccessible to the larger public. The language used (mainly English) in these newspaper adverts plays a role in ensuring that the readers read, absorb and understand the contents as intended. Although Kenya has a high literacy level of over 75% and that English is a national language, the message may be lost because of inadequate interpretation (Obonyo, 2010; Okello et al., 2012). This could be the probable reason why despite the county government's indication that they placed an advert for the project in a daily newspaper, only 9.1% accessed this information from the print media (Figure 16).

Majority of respondents from the household survey mentioned local leaders as their primary source of invitation to participate in the project. Even though it formed the major source of information, some respondents observed that the local leaders in most cases exercised bias, inviting only 'their friends and relatives to gain from the monetary incentives offered'[13] as participation compensation. The development and use of these PSS tools can play a great role in mitigating such risk. It is also open to manipulation by 'influential stakeholders and politicians' who may use the leaders to front their personal, sectorial or political agenda (Ngau, 2013; Okello et al., 2012; Onyach-Olaa, 2003) at the expense of the public good. A contrary observation was made from a survey carried out among practising planners. From a total of 185 respondents, majority expressed awareness of only print (newspapers), on-site and public notice

[13] *Key concern from most respondents interviewed about the effectiveness of using local leaders as a mobilizer.*

boards as the common practise for inviting public participation. Figure 22 show that only 25% (47 out of 185) confirmed knowledge of the use of verbal invitation. This confirms that verbal invitation is not a very common practise of disseminating information and inviting participants in Kenya in as far as public participation is concerned. However, it appears some local authorities, Kisumu for example, still use it to pass information to the general public. An interactive web-portal opens communication channels which eliminate the need for and influence of community leaders and powerful politicians and stakeholders in the process. For example, SMS linked to a geoportal can facilitate an anonymous participation option, ensuring not only more but also equitable participation, eliminating discriminatory invitation by leaders.

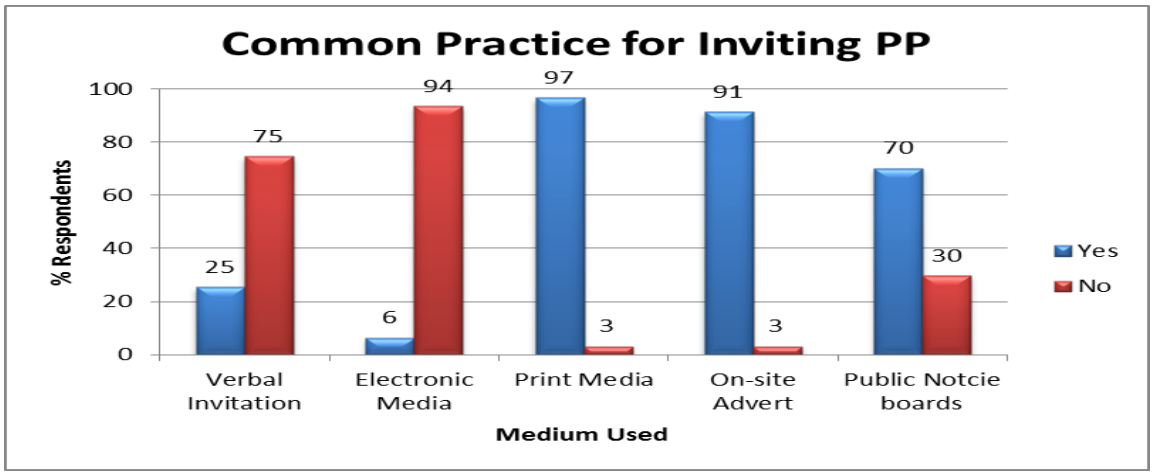

Figure 22: Media through which citizens received invitation to public participation in planning processes

It is not always possible for the public to be involved in all major decisions or action (Jelagat & Barasa, 2013; Masinde & Musungu, 2010; Onyach-Olaa, 2003; Wells et al., 2008) or all stages of the planning process. It is therefore quintessential for any planning body to first clarify for itself and the public the specific issues and questions where public input is desired and where the public can have influence (Jelagat & Barasa, 2013; Okello et al., 2012). This will aid in identifying the types of input required and the extent to which such input may be required from the public and used by the agency. It also helps to identify possible constraints to public participation and define the roadmap to an effective and meaningful participation.

To establish the levels of public participation achieved using the existing planning processes and tools and the methods used to invite and conduct public participation, survey data was significantly used for the analysis. From the household survey carried out in the neighbourhood where the proposed redevelopment is to occur, 25% were aware of the proposed redevelopment. Out of those aware, only 44% (11 out of 25) received invitation to participate, with majority (over 70%) getting the information from local leaders. This points to a likely scenario where invitations to public meetings do not reach the intended public. It is perhaps for this reason that a lesser percentage received invitation to participate. However, out of those who received invitation, 81% attended and participated in the public meetings organized by the project proponents. This shows higher level of participation recorded. Over 85% of

residents interviewed (Table 18) expressed their readiness and willingness to participate in the future planning process if such invitation reached them.

Table 18: Residents' willingness to participate in future planning processes

Willingness_to_participate				
		Frequency	Percent	Valid Percent
Valid	Highly likely	31	39.7	39.7
	Likely	36	46.1	46.1
	Unlikely	7	9.0	9.0
	Highly unlikely	2	2.6	2.6
	Dont know	2	2.6	2.6
	Total	78	100.0	100.0

The research also revealed various reasons why residents are motivated to participate. Wells, Ward, Feinberg, & Alexander (2008), while looking at what motivates participation of members in community coalitions in the US categorised the motivators into three domains. These are interpersonal (an enhanced sense of group identification where "you" becomes "we", and enjoyment of leading and organizing), instrumental (relating to private benefits only achievable through participation in the coalition-monetary value, intangibles such as better information about the local community, and increased agency legitimacy) and normative goals (collective public goods like population well-being, duty, responsibility, values etc.) (Wells et al., 2008).

Table 19: Reasons that motivated residents to participate

Reasons_for_Participating				
		Frequency	Percent	Valid Percent
Valid	Financial compensation	2	2.0	20.0
	Idea contribution to whole process	7	7.0	70.0
	Just listen to presentations	1	1.0	10.0
	Total	10	10.0	100.0

Majority of residents interviewed (70% in Table 19) showed particular interest in contributing ideas to the planning processes rather than for financial compensation, expressing both their instrumental and normative goals. This further solidifies the claim that residents are willing to participate, but perhaps the channels used to disseminate information or invitations to participate do not achieve optimum circulation. This is also seen in the results from practising planners, where 77.3% of respondents (Table 20) observed that the medium used to invite public participation has not achieved optimum or satisfactory levels.

Table 20: Do the current methods used to invite public participation guarantee optimum participation?

Optimum_PP			
		Frequency	Percent
Valid	yes	42	22.7
	no	143	77.3

The impacts of the integration of 3D modelling and visualization as a PS tool and E-participation can be deduced from the indicators mentioned in section 4.2, that is, Satisfaction, Communication, Collaboration, Efficiency, Effectiveness, and Learning (SCECEL) capabilities of the PS tool.

Evaluated based on the number of correct questions answered in the group tasks, participants showed that the use of the 3D web-based tool was more effective than the 2D paper-based representations. Effectiveness varied with the different professional groupings, with planners and surveyors scoring higher than other groupings. There was no significant difference between 2D and 3D correct answers for the engineers' group. But with all groups recording scores of over 50% in both tasks, we conclude that the two methods are all effective, only varying in degrees of effectiveness. The differences noted among various groups confirms the assertion by te Brömmelstroet (2015) that differences in use of such tools depend on differences in backgrounds, professional languages and skills of users.

Efficiency was evaluated based on the time taken to answer the task questions correctly. In this aspect also, the 3D tasks took shorter times to answer than the 2D task. However, for Surveyors, the task completion time was almost equal. In the dispensation of the tasks, the task sequence was varied for the two workshops. In workshop 1 (students), the 2D tasks were executed first followed by the 3D task. For the second workshop, the 3D task was completed first before the 2D one. From this sequence, it was hard to tell if the sequence of tasks influenced the results. However, future studies may consider varying the sequence of or the tasks among the different professional groups to determine any impact varying of the sequencing on results.

Participant's satisfaction was gauged based on their preferential choices between 2D and 3D. From the results, it is observed that 83.8% of the respondents from the workshops felt satisfied with the 3D tool and its capabilities and may consider 3D over 2D presentations in future planning work. This may be related to the learning concept where over 80% of respondents opined that the 3D tool improved their understanding, thus increasing satisfaction rating. The presentation of the redevelopment area in its present state and again in its redeveloped state gave the participants a more detailed insight into the aesthetic and density dimensions of the proposed redevelopment. From the comments made by respondents in the questionnaires, we conclude that the respondents identified more with realistic and precise representations in 3D as opposed to 2D. A similar observation was made by Mansholt Publication (2007)

Another important role played by PSS is to enhance interdisciplinary communication through learning (Pelzer & Geertman, 2014). In both tasks, some level of communication was reached based on the

learning curves described in subsection 4.2. However, the 3D web-based tool still scored higher in this respect. Some participants were more concerned with what they actually learnt from the PS tool (outcome) rather than how the tasks were done (process). This corroborates views held by Pelzer et al. (2016) that learning is perceived by users to be the most important added value of any PSS applications. Pelzer & Geertman, 2014 argue that tool involvement prior to or during workshops seems to be both an important prerequisite for learning, and a learning process in itself.

A correlation analysis performed (Table 21) showed that the Ease of Use and participants consideration of 3D over 2D had a strong positive correlation to the professional background of participants (0.266 and 0.186 respectively). This perhaps informs the variations in effectiveness and efficiency between different professional groups, confirming te Brömmelstroet (2015) claim that differences in use of such tools depend on differences in backgrounds, professional languages and skills of users.

Table 21: Correlation table.

		Profession	EoUse2D	EoUse3D	Consider2D_over3D	Consider3D_over2D
Profession	Pearson Correlation	1	-.251	.266	-.126	.186
	Sig. (2-tailed)		.134	.111		.278
	N	37	37	37	37	36
EoUse2D	Pearson Correlation	-.251	1	-.142	-.365*	.395*
	Sig. (2-tailed)	.134		.401	.026	.017
	N	37	37	37	37	36
eoUse3D	Pearson Correlation	.266	-.142	1	.253	-.313
	Sig. (2-tailed)	.111	.401		.132	.063
	N	37	37	37	37	36
Consider2D_over3D	Pearson Correlation	-.126	-.365*	.253	1	-.910**
	Sig. (2-tailed)	.457	.026	.132		.000
	N	37	37	37	37	36
Consider3D_over2D	Pearson Correlation	.186	.395*	-.313	-.910**	1
	Sig. (2-tailed)	.278	.017	.063	.000	
	N	37	37	37	37	37

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

It is however important to point out that all the two workshops were semi-mediated and guided, where users were taken through what to do. Perhaps such a workshop setting may produce different results from those where the PSS is chauffeured or fully mediated, or even in cases where each individual may be let to run the PSS outside a workshop set-up.

4.4. Limitations.

While PSS science is gaining ground in participatory planning, previous research had focused more on instrumental characteristics and theoretical accounts rather than empirical discourse focusing on their

impacts and added value in spatial planning. One limitation of such experimental study of PSS is that there exists no defined conventional framework for assessing or measuring impacts of a PSS. Similarly, it is hard to clearly establish which sets of indicators to use for measuring impacts and/or perceived added value.

This study suffers some setbacks. First, it was done in a controlled environment. However, critics of such set-ups argue that controlled settings leads to external validity concerns on whether a workshop with few participants reflects real-world planning practice to a sufficient degree (Pelzer et al., 2016). Secondly, this study is a single case study, and it remains unrealistic to generalize the findings to other instances in which a PSS was or may be applied. This is because planning issues are unique to areas, neighbourhoods and the people and there exists not a one-fits-all solution. It is important that each PSS remains cognisant of planning needs and uniqueness at any particular time.

4.5. Conclusion.

The analysis of the study results show a consistency with what most researchers have argued for, that different PSS have potential impacts on public participation. The study showed a convergence in agreement among the various professionals, students and the general public that 3D presentations have greater potential to improve public participation due to its ability to depict scenarios as close to reality as possible. This enhances understanding since humans are capable of relating easily with visual impressions rather than paper based maps which are just a combination of texts, lines and polygons. The addition of interactive capabilities makes it more flexible and easier to use, enabling information exchange and learning. It is however noteworthy that every PSS may trigger different reactions from the users depending on the complexity of the tool, the design and its purpose, hence the argument that PSS should be context-specific. The task design, the methodology and execution for this study allowed the realisation of the study objectives.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1. Introduction.

This study sought to assess the impacts of 3D visualization and E-participation on public participation. The study was guided by four objectives. This section presents the conclusions derived from the analysis of the study processes and results, and further provides recommendations on what needs to be done and for future research.

5.2. Conclusions.

The County Government of Kisumu operates its spatial planning functions guided by the Physical Planning Act (PPA Cap 286), the Kenyan Constitution and the City Bylaws. These regulations mandate the authority to involve citizens in the planning processes. Spatial planning is done at different levels depending on the scope of the plan. Developments plans initiated by the county government are subject to advertisement on a local daily to invite public comments and/or objections. However, it was noted that there were neither records kept to ascertain the involvement of the public through public forums nor documentation of comments/objections received over the past few years. Whether this was deliberate or not was not ascertained, but it shows lack of transparency and accountability especially the inability to establish an audit trail of the process.

The common method of inviting public participation is by advertising proposed plans on Local Newspapers. Other channels include on-site advertisement and use of local community leaders. It was evident that the use of community leaders to disseminate information to the public was a common practise. However, challenges were noted as to their neutrality in inviting or selecting participants. A common concern that came up was their preferential invitation to friends and /or relatives due to the promise of monetary gains from participation. Newspaper advertisements remained unpopular, with residents citing its inaccessibility due to cost, and that often the advertisements are too small to notice in a page of a newspaper. It was also evident that residents at times shied away from participation for fear of victimization by their leaders. Nevertheless, it is worth noting that local radio stations with local community language (vernacular) have a great potential for information sharing. Most respondents in the household survey noted their preference for local radio based on its ease of access and the advantage of broadcast in a local language.

In most spatial planning processes, results showed that the public is usually invited at the tail-end of the process, where they are only limited to viewing the plans, writing comments and/or objections to the proposed process. While involving the public at earlier stages of plan preparation may be costly and time consuming, it harbours the advantage of bringing in extra local knowledge that will make the plan more responsive and realistic to local needs. At the same time, this may win public approval due to the general feeling that it was 'done by us.' In some cases however, this is not a guarantee.

For meaningful public input, it is paramount that every planning agency should first establish the goals of public participation, how it is to be carried out and the foreseeable constraints. It is not always possible to involve the public in all major decisions, at every stage, or in all aspects of any given planning decision. It is therefore essential that a planning agency clarifies for itself and the public specific issues and areas where public input is desired and where the public can exercise their influence.

The proposed redevelopment is a project initiated by the county government of Kisumu, aimed at providing decent affordable housing to the city residents. There were no records availed from the county government (plan details, records of public participation etc.). We later established through a follow-up telephone interview with key Informant 1 that the project is more political, explaining why plan details are closely guarded. However, the household survey carried out showed that more than half the population interviewed were not aware of the project. Even for those who were aware, less than 40% received invitation to attend public forums from the local leaders. This shows that the local leaders had the information, but the fact that it did not reach more than half the population confirms residents' fears that leaders could be biased and motivated by desire to have their kin and friends benefit financially.

Varying factors influence the choice of method used to incite public participation as well as the processes itself. At the centre stage is politics and the level of democracy of a country. Politics determines the types of policies and legislations that regulate physical planning. Further, politicians exercise control, directly or indirectly, on public participation methods. The medium used to invite public participation to a great extent influences the class and number of population reached by such information. For example, local leaders can easily disseminate information to their subjects while newspapers may not be accessible by a particular class of people, especially the poor. Literacy levels also determine information interpretation and consumption. Semi-literate or illiterate masses of the population may find it easier to conceptualise ideas presented in local language than those presented in English, making vernacular radios a popular option.

From the experiments carried out, it was evident that 3D visualization and E-participation can have potential impacts on public participation. While such impacts could prove hard or even impossible to measure or quantify, it is essential that particular indicators be used for this task. Communication and information exchange is enhanced more using interactive web-based geoportal than while using 2D paper presentation which is a one-way information relay. The improvement in exchange of information and communication fosters better learning. The flexibility of the 3D geoportal makes it easier and faster to use, explaining the preference over 2D maps in terms of effectiveness and efficiency. Generally, users felt satisfied with the 3D tool as opposed to the 2D one, with a majority indicating that they would consider using such tools for future presentations in planning workshops.

5.3. Recommendations

From the study, it was evident that E-participation has the potential to increase public participation. It was clear from the literature reviewed that there exists no explicit provision in the legislation for public participation, defining how and at what stage the public may be involved in the planning process. We

therefore recommend policy review to clearly define public participation on how and when the public can be involved. Such legislation should also define in explicit terms the roles and responsibilities of the public during public participation. Further, we recommend institutionalization and appropriation of such PSS to aid in planning work not only in the city, but also in the county and/or the country in general.

There is need for a more structured and transparent way of documenting spatial planning processes and procedures, such that details of public participation can be retrieved from the planning agencies. This will help build confidence in the general public that at least their views and participation are not taken lightly, thereby increasing their motivation and likelihood to participate. Results showed political or personal influence especially in the way information is relayed to the public and how public participation is carried out. There is need for civic education on the roles and responsibilities of citizens in as far as public participation is concerned. Civic education empowers citizens to have more say and be civic 'guards' to the processes happening around them.

Collaboration is vital for any public participation exercise. However, from interviews, it was evident that different departments and stakeholders sometimes do not work together to achieve spatial planning goals. The study recommends a structured collaboration between and amongst different departments and stakeholders in the spatial planning domain of the city.

It would be an added advantage to the city to develop a stand-alone 3D city geo-portal, and explore its possibilities with different planning projects to assess its full impacts and possibilities. While it is not a guarantee that this may increase the quantity and quality of public participation, research has documented huge benefits that the city government may consider exploring.

5.4. Future Research

From reviewed literature, it was clear that even though PSS have positive impacts, there is no particular framework for measuring the impacts or the added value of such PSS. Further research may focus on more advanced but comprehensive indicator-based framework development that takes into account methodologies for assessing the impacts for different stages or process of spatial planning.

For future research, we recommend the development of a full stand-alone 3D web-geoportal. This will enable the development of the portal in a way that the developer has controls and can assign different levels of access and user rights. More research may also focus on integrating mobile phone applications (USSD/SMS/Smart Apps) into the web-portal and how these can be used to accommodate local knowledge via participatory mapping or the inclusion of varied interests and input from different stakeholders. For representativeness, such PSS should be tested in more different case studies.

Future research may also look into other cheaper ways of 3D modelling of larger city areas, using free or open source software but with acceptable output. Areas that can be looked into is how to integrate images obtained cheaply via mobile phones into the modelling process to give it a more realistic perspective.

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APPENDIX:

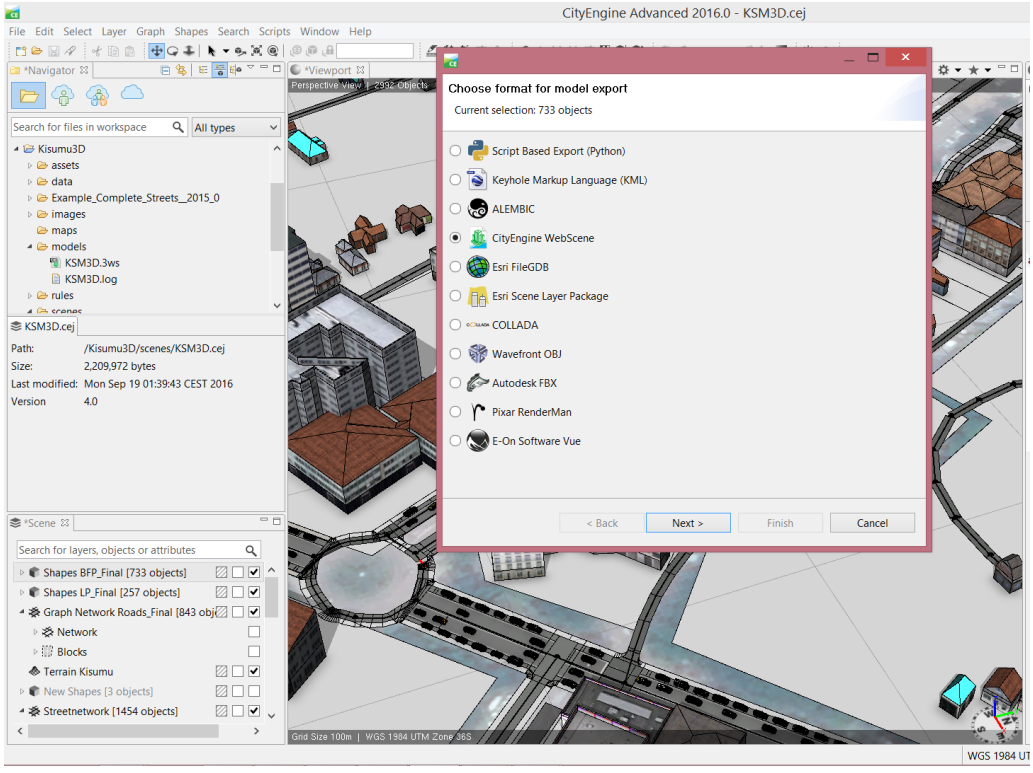
Annex 1: Constitutional Excerpts on public participation from the Kenya Constitution

Article No.	Sub-section	Excerpt
16	**2**	*A regional physical development plan may be prepared by the Director with reference to any Government land, trust land or private land within the area of authority of a county council for the purpose of improving the land and providing for the proper physical development of such land, and securing suitable provision for transportation, public purposes, utilities and services, commercial, industrial, residential and recreational areas, including parks, open spaces and reserves and also the making of suitable provision for the use of land for building or other purposes (Kenya, 2002 p. 15).*
21	**2**	*The Cabinet Secretary shall, at least fourteen days before commencement of the preparation of a National Physical Development Plan, publish a notice in the Gazette and in at least two newspapers of national circulation of the intention to prepare a National Physical Development Plan*
	3	*A notice published in accordance with this section shall state the objectives of National Physical Development Plan, the purpose of the National Physical Development Plan and the matters to be addressed in the plan; and the places where members of the public may provide written proposals for the National Physical Development Plan.*
23	**1**	*Within thirty days of the preparation of the National Physical Development Plan, the cabinet Secretary, shall publish a notice in the Gazette and in at least one newspaper of national circulation informing the public that the draft National Physical Development Plan is available at the places and times designated in the notice for inspection and that any interested person may comment on the content of the draft National Physical Development Plan.*
24	**1**	*The Director may prepare with reference to any Government land, trust land or private land within the area of authority of a city, municipal, town or urban council or with reference to any trading or marketing centre, a local physical development plan.*
	3	*The Director may prepare a local physical development plan for the general purpose of guiding and coordinating development of infrastructural facilities and services for an area referred to in subsection (1), and for the specific control of the use and development of land or for the provision of any land in such area for public purposes (GOK, 2002) p. 17).*
47	**1**	*A city or county government as the case may be, shall prepare, a local physical development plan*

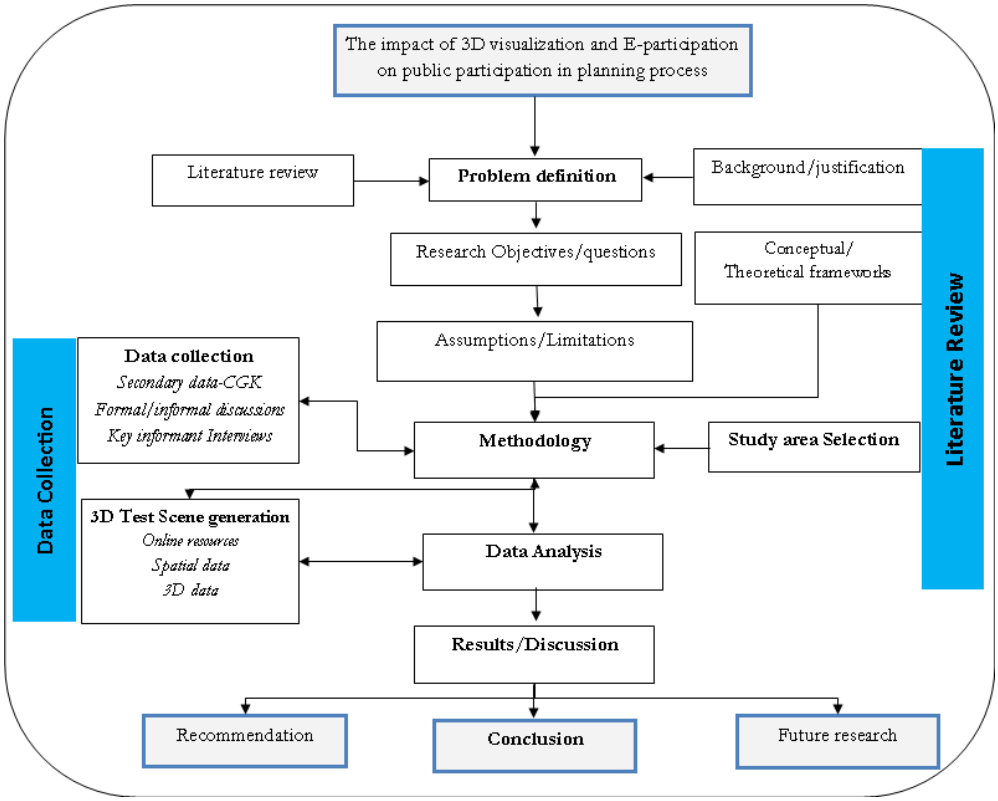
50	**1**	*Within thirty days of the preparation of, a local physical development plan, a city or municipal officer in charge of physical spatial planning shall publish a notice in the Gazette and in at least one newspaper of national circulation informing the public that the plan is available at the places and times designated in the notice for inspection and that any interested person may comment on the content of the plan.*
53	**5**	*A county government may publish such Regulations as may be necessary to promote public participation during the process of declaring an area a special planning area.*
61	**5**	*An applicant or an interested party that is aggrieved by the decision of the planning authority regarding an application for development permission may appeal against that decision to the County Spatial Planning Tribunal within fourteen days of the decision by the authority and that committee shall here and determine the appeal within fourteen days of the appeal being filed.*

Source: Adapted from The Physical Planning Bill 2015.

Annex 2: Caption of CityEngine main menu and export options available



Annex 3: Overall research workflow



Annex 4: Research work plan

Month / Activity	July	August	September	October	November	December	January	February
Literature Review								
Supervisor Review								
Field Preparation								
Field Work								
Data preparation								
Data Analysis								
Mid-term Review								
Final Report Writing								

Annex 5: Contingency plans

Risk	Contingency measure
Building heights data not available	Apply Image Analysis techniques to get heights Assign arbitrary heights to the buildings Collect during fieldwork
Geo-portal not accessible due to server issues	Present the 3D visual models to the FGDs
Inability to create an auto e-mail/sms dispatch	Obtain email and mobile contacts for the residents

geoportal	of the study area and dispatch personal emails/sms. Use social media (WhatsApp, Facebook, Telegram) to dispatch questionnaire links.
City planning officials unavailable/bureaucracy.	Prior notification before fieldwork. Obtain information from other clerks/registered and practicing planners within Kisumu

Annex 6: Key Informant Interview Questions

Impacts of 3D visualization and E-participation on public participation.

Impacts Survey

This survey is part of a research project on assessing the impact of 3D visualization and E-participation in planning processes. The research is conducted by Onyimbi Ragot, an MSc student at Faculty of Geo-Information Science and Earth Observation at the University of Twente, the Netherlands. Your participation is highly appreciated and is of great help to the realization of the project objectives. I confirm that the responses and feedback will be kept anonymous and confidential and will solely be used for this research project. Please fill this form as part of your participation in helping develop more understanding on this research. Thank you for your cooperation.

Please respond to the following questions on your satisfaction with the visualization methods presented.

(*Please tick one choice per question unless otherwise indicated*)

A. Questions on Public participation

Is there a regulatory requirement for public participation in planning processes?

How do you engage the public in the city planning processes?

How does the city government invite public participation?

What factors do you think influence the choice of the method(s) above?

Based on your past experience, how would you rate public perception and responses towards these methods used?

During stakeholder meetings, how are plans currently presented? *(offer lead if not clear eg paper-based 2D, Paper-based 3D, etc)*

In your opinion, what challenges face the full implementation of public participation in planning processes?

B. Questions on E-participation

Have you ever considered using e-participation (mobile phone sms/ussd services, emails etc.) channels in inviting the public to participate in planning processes? *(If yes, continue to next. If not proceed to section C).*

Have you used e-participation in any planning process?

What is your take on the possibilities offered by the methods your office uses now and the possibilities offered by e-participation?

C. Questions on 3D visualization

Are you aware of the possibility of visualizing and presenting the plans, designs and different scenarios in 3D?

Has the government considered using 3D representation of urban environment during planning stakeholders' meeting?

Would you recommend the government to use innovative methods for visualisation such as 3D?

Between 2D and 3D visualizations, which would you choose for public presentations and why?

In your opinion, what can be done to improve Public participation and involvement in planning processes in Kisumu City?

Disclaimer: If you are interested to be interviewed or contacted later about the use of 3D visualization on public participation/planning processes, and especially for this research, please provide your contact information below (optional). Kindly note that your views will be treated with confidentiality and anonymity throughout this research.

Name:

Phone no:

Email:

Annex 7: End-of-Workshop Questionnaire

Impacts of 3D visualization and E-participation on public participation.

Impacts Survey

This survey is part of a research project on assessing the impact of 3D visualization and E-participation in planning processes. The research is conducted by Onyimbi Ragot, an MSc student at Faculty of Geo-Information Science and Earth Observation at the University of Twente, the Netherlands. Your participation is highly appreciated and is of great help to the realization of the project objectives. I confirm that the responses and feedback will be kept anonymous and confidential and will solely be used for this research project. Please fill this form as part of your participation in helping develop more understanding on this research. Thank you for your cooperation.

Please respond to the following questions on your satisfaction with the visualization methods presented.

(*Please tick one choice per question unless otherwise indicated*)

D. Questions on 2D visualization

	Based on your experience today , kindly rate the 2D presentation based on the following	**Very good**	**good**	**Bad**	**Very bad**	**Not sure**
1.	Level of Details presented	☐	☐	☐	☐	☐
2.	Ease of understanding the scenes and contents	☐	☐	☐	☐	☐
3.	Ability to easily navigate through the presentation	☐	☐	☐	☐	☐
4.	Ease of use of the 2D presentations	☐	☐	☐	☐	☐
5.	Realism of objects presented.	☐	☐	☐	☐	☐

E. Questions on 3D visualization

	Based on your experience today , kindly rate the 3D presentation based on the following	**Very good**	**good**	**Bad**	**Very bad**	**Not sure**
6.	Level of Details presented	☐	☐	☐	☐	☐
7.	Ease of understanding the scenes and contents	☐	☐	☐	☐	☐
8.	Ability to easily navigate through the presentation	☐	☐	☐	☐	☐
9.	Ease of use of the 2D presentations	☐	☐	☐	☐	☐
10.	Realism of objects presented.	☐	☐	☐	☐	☐

F. General comparisons

Strongly Agree	**Agree**	**Not sure**	**Disagree**	**Strongly disagree**

11.	The 3D visual model improved my understanding of the possible scenarios and impacts of urban development	☐	☐	☐	☐	☐
12.	The 2D visual model improved my understanding of the possible scenarios and impacts of urban development	☐	☐	☐	☐	☐
13.	What I learned from the 3D visualization changed my thought on ways of visualizing scenes in planning.	☐	☐	☐	☐	☐
14.	3D visualization was easy to understand better than 2D presentation	☐	☐	☐	☐	☐
15.	2D visualization was easy to understand better than 3D presentation	☐	☐	☐	☐	☐
16.	2D visualization is more flexible to deal with	☐	☐	☐	☐	☐
17.	3D visualization is more flexible to deal with	☐	☐	☐	☐	☐

18. What aspects didn't you like in the 2D presentation?

Reasons for your answer ----------

---

19. What aspects didn't you like in the 3D presentation?

Reasons for your answer ----------

---

20. Would you consider 2D over 3D presentations for your planning work, especially for public participation? *(Tick one)*

☐ **Yes**

☐ **No**

Reasons for your answer ----------

---

21. Would you consider 3D over 2D presentations for your planning work, especially for public participation? *(Tick one)*

☐ **Yes**

☐ **No**

Reasons for your answer ----------

---

22. Give any final comments on the usability of 3D visualization for public participation

---

---

23. What suggestions do you have to improve public participation in general in the future?----------
---

Disclaimer: If you are interested to be interviewed or contacted later about the use of 3D visualization on public participation/planning processes, and especially for this research, please provide your contact information below (optional). Kindly note that your views will be treated with confidentiality and anonymity throughout this research.

Name:

Phone no:

Email:

Annex 8: Household Survey Questionnaire

Impacts of 3D visualization and E-participation on public participation.

Impacts Survey

This survey is part of a research project on assessing the impact of 3D visualization and E-participation in planning processes. The research is conducted by Onyimbi Ragot, an MSc student at Faculty of Geo-Information Science and Earth Observation at the University of Twente, the Netherlands. Your participation is highly appreciated and is of great help to the

realization of the project objectives. I confirm that the responses and feedback will be kept anonymous and confidential and will solely be used for this research project. Please fill this form as part of your participation in helping develop more undertaking on this research. Thank you for your cooperation.

A. Please respond to the following questions about your participation in planning processes. (*Please tick one choice per question unless otherwise indicated*)

	Yes	No
1. Are you aware of the planned redevelopment (reconstruction) of the…….(s)? *(If yes, proceed to Q2, if no jump to Q14)*	☐	☐
2. Have you ever been invited to participate at any stage of this project? *(If yes, proceed to Q3, if no jump to Q14)*	☐	☐

	By a leader	On-site Advert	Print: N/paper/flyers	Public Notice Board	Radio/Tv/ Sms/email
3. How were you invited? *(multiple answers allowed)*	☐	☐	☐	☐	☐

	Yes	No
4. Did you attend and participate in the stakeholder meetings? *(If yes, proceed to Q5, if no jump to Q14)*	☐	☐

	Participant	Observer	Facilitator	Don't know	Other-specify
5. What was your role in the meeting?	☐	☐	☐	☐	☐

6. What were your reasons for participating?
   - ☐ For financial compensation
   - ☐ To contribute my ideas and thoughts to the whole process
   - ☐ To accompany a friend/relative
   - ☐ To listen to the presentations
   - ☐ Others *(specify)*……

B. For the following section, please tick one box per question.
How would you respond to the questions below? Be as honest as possible

	Questions	Very true	May be true	True	Not true	Don't know
7.	The method of inviting public participation was transparent	☐	☐	☐	☐	☐
8.	The process of public participation was well conducted	☐	☐	☐	☐	☐
9.	The plan presentation method made you understand the contents	☐	☐	☐	☐	☐
10.	You shared your opinions with other participants	☐	☐	☐	☐	☐
11.	All participants were offered equal opportunity to participate	☐	☐	☐	☐	☐
12.	All issues raised by participants were clearly addressed	☐	☐	☐	☐	☐
13.	Your views were taken into consideration in the process	☐	☐	☐	☐	☐

		Highly Likely	Likely	Unlikely	Highly Unlikely	Don't know
14	Would you be willing to participate in future planning processes?	☐	☐	☐	☐	☐

15. What are your reasons for the choice in Q14 above

……
……
……
……

C. Please respond to the following open questions about methods of inviting public participation

16. In future, which among these methods would you prefer to be used for inviting public participation (multiple answers possible)?

☐ By community leaders
☐ By on-site paper advertisements
☐ Print: Newspapers, Flyers, etc
☐ Notices placed on public notice boards in public offices

☐ Radio/Tv/emails/sms

☐ Others (specify……..)

Reasons for your choice ----------

---

17. What suggestions do you have to improve ways of inviting public participation in the future?

---

18. What suggestions do you have to improve public participation in general in the future?----------
---

Disclaimer: If you are interested to be interviewed or contacted later about public involvement in planning processes, and especially for this research, please provide your contact information below (optional). Kindly note that your views will be treated with confidentiality and anonymity throughout this research.

Name:

Phone no:

Email:

Annex 9: General Survey Questionnaire

Impact of 3D visualization and E-Participation on Public participation: Case of Kisumu City

Impacts of 3D visualization and E-participation on public participation.

Impacts Survey

This survey is part of a research project on assessing the impact of 3D visualization and E-participation in planning processes. The research is conducted by Onyimbi Ragot, an MSc student at Faculty of Geo-Information Science and Earth Observation at the University of Twente, the Netherlands. Your participation is highly appreciated and is of great help to the realization of the project objectives. I confirm that the responses and feedback will be kept anonymous and confidential and will solely be used for this research project. Please fill this form as part of your participation in helping develop more understanding on this research. Thank you for your cooperation.

Please respond to the following questions on your knowledge and satisfaction with the use of 3D visualization and E-participation for public participation in planning processes.

(Please tick one choice per question unless otherwise indicated)

1. How long have you been in planning practice?

- ○ 0-2yrs
- ● 2-4yrs
- ○ 4-6yrs
- ○ 6-8yrs
- ○ >8yrs

2. Have you ever been involved in a planning project that required public participation?

- ● Yes, I have been involved
- ○ No, I have not

3. Are you aware of any statutory regulations (Acts, by-laws, etc) requiring public participation in planning processes? (Give examples)

- ● Yes
- ○ No

4. Give examples of the regulations in Q3 above.

the constitution of kenya, the county government act and local laws in each county in kenya give room for Public

5. Based on your experience, how would you describe how the public currently gets involved in planning processes?

	Fully Involved	Partially Involved	Not Involved
Problem identification & policy setting	●	○	○
(Provide a brief explanation for your choice			
the people are used in identifying the problems and prioritizing the needs			
Alternative solutions/scenario development	○	●	○
(Provide a brief explanation for your choice			
much of this is done by experts who weigh alternatives and choose the best for people alt			
Project selection	○	●	○
(Provide a brief explanation for your choice			
similar to the alternatives development. Selection of project depends much on experts an			
Project Implementation	●	○	○
(Provide a brief explanation for your choice			
i have seen many projects were people are ion control. This is seen in how they take part			
Monitoring & Evaluation	○	●	○
(Provide a brief explanation for your choice			
Development control	○	○	●
(Provide a brief explanation for your choice			
its more of policy affairs.			

6. Choose the methods used currently to invite public participation in planning processes?

	Verbal Invitation by a leader	On-site paper advertisement	Print media: Newspapers, flyers etc	Notice Boards in public offices	Electronic media: Raido, Tv, sms, email etc
Ways of Inviting Public Participation	☐	☐	☑	☑	☑

Describe the Method(s) chosen

methods are used for different groups. I learn from a research i did that government use various methods including vernacular TV/Redio stations

7. Do you feel the method(s) above achieve optimum public participation? Give reasons)

- (●) Yes
- ( ) No

Reasons

I realised that many counties in kenya for example use different methods to reach different people group. it was soo effective

8. What would you suggest to improve public participation in the future?

capacity building . if people know the importance, they will participate

9. Are you aware of the use of 3D visualization for plan/project presentations?

- ( ) Yes, I am Aware
- (●) No, I am not aware

10. Have you ever used 3D visualization for plan presentations?

- ( ) Yes
- (●) No

11. How satisfied are you with the 2D visualization and presentation of planning projects?

	Very satisfied	Somewhat satisfied	Least satisfied	Not satisfied at all	Dont know
Ease of use	●	○	○	○	○
Ease of understanding	●	○	○	○	○
Level of detail	○	●	○	○	○
Stakeholder satisfaction	○	○	○	○	●
Level of realism	○	●	○	○	○

12. How satisfied are you with the 3D visualization and presentation of planning projects?

	Very satisfied	Somewhat satisfied	Least satisfied	Not satisfied at all	Dont know
Ease of use	○	○	○	○	●
Ease of understanding	○	○	○	○	●
Level of detail	○	○	○	○	●
Stakeholders satisfaction	○	○	○	○	●
Level of realism	○	○	○	○	●

13. Would you recommend the use of 3D visualization for planning purposes? (Give reasons)

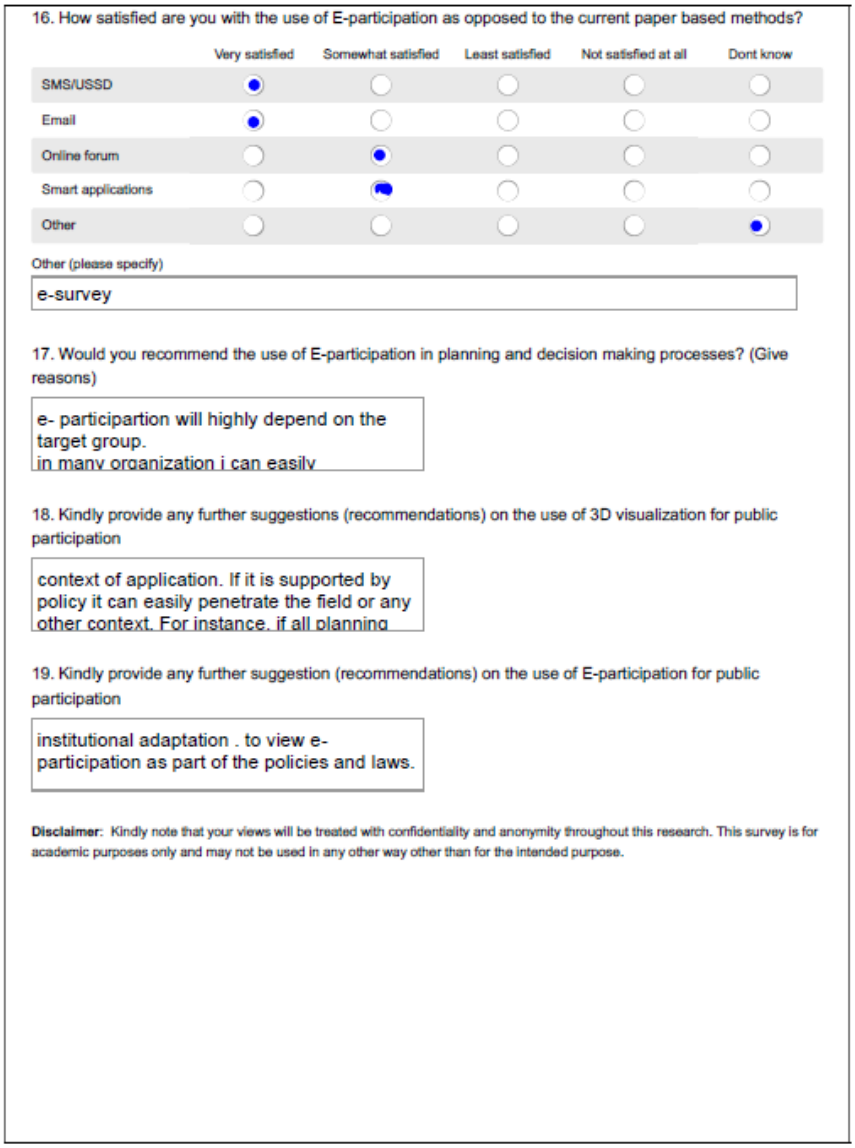
if the people involved in the process understand 3D and can bring out the best of it.

14. Are you aware of the use of E-participation in planning processes?

- ● Yes
- ○ No

15. Have you ever used E-participation in any planning process?

- ● Yes
- ○ No



16. How satisfied are you with the use of E-participation as opposed to the current paper based methods?

	Very satisfied	Somewhat satisfied	Least satisfied	Not satisfied at all	Dont know
SMS/USSD	●	○	○	○	○
Email	●	○	○	○	○
Online forum	○	●	○	○	○
Smart applications	○	●	○	○	○
Other	○	○	○	○	●

Other (please specify)

e-survey

17. Would you recommend the use of E-participation in planning and decision making processes? (Give reasons)

e- participartion will highly depend on the target group.
in many organization i can easily

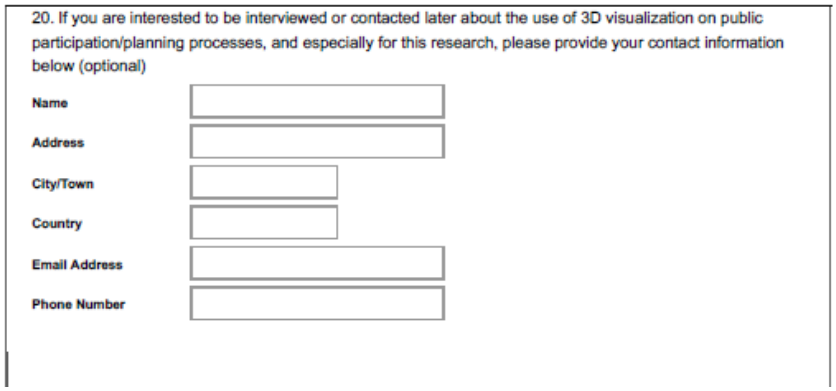
18. Kindly provide any further suggestions (recommendations) on the use of 3D visualization for public participation

context of application. If it is supported by policy it can easily penetrate the field or any other context. For instance, if all planning

19. Kindly provide any further suggestion (recommendations) on the use of E-participation for public participation

institutional adaptation . to view e-participation as part of the policies and laws.

Disclaimer: Kindly note that your views will be treated with confidentiality and anonymity throughout this research. This survey is for academic purposes only and may not be used in any other way other than for the intended purpose.



20. If you are interested to be interviewed or contacted later about the use of 3D visualization on public participation/planning processes, and especially for this research, please provide your contact information below (optional)

Name

Address

City/Town

Country

Email Address

Phone Number

Annex 10: Task Sheets

a). 3D Tasks

Instructions: Navigate through the scenes, click on the symbols (demonstrate) and a letter will appear. Identify the objects labelled with letters on the 3D web portal. Navigate

A……..

B……

C……

D……

E……

F……

G……

H……

I…….

J…….

b). 2D Tasks

Mark the location of the following places on the map provided. Once you have identified the object on the map, Use the corresponding numbers below to mark it on the map

1. Ardhi house
2. Huduma center
3. ACK cathedral
4. Kisumu high court
5. Provincial police Headquarter
6. Jomo Kenyatta sports ground
7. Mega Plaza
8. Reinsurance plaza
9. Alpha House
10. Tivoli centre

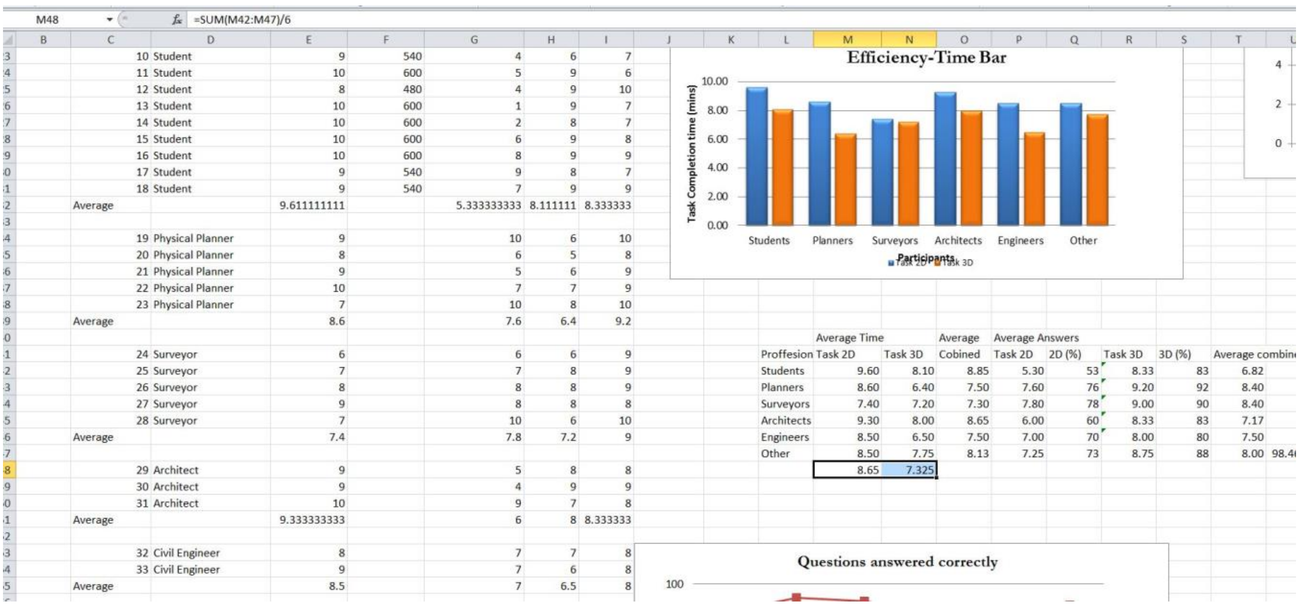
Annex 11: List of Key informants

No.	Responsibility	Date of Interview	Place	Experience (years)	Mode	Consent
1	City Planning official	Thurs. 6/10/2015 10.30am	City Hall	7	Guided Interview	Consent sought,
2	Deans, SoP (Maseno)	Tues 11/10/2015, 2.00pm	Deans Office	15	Guided Interview	Consent Sought
3	Practising Private	Wed 5/10/2015, 12.30pm	After	20	Guided	Consent

	Planner		workshop		Interview	sought
4	Architect, County Govt. Kisumu	Fri 14/10/2015, 10.00am	Architects Office	5	Guided Interview	Consent sought,
5	Project Manager, Muungano NGO	Fri 14/10/2015, 3.00pm	Manager's Office	5	Guided Interview	Consent sought

Annex 12: Example of the 2D map used in the Workshop tasks

Annex 13: Caption of Data used for analysing Efficiency and Effectiveness



	C	D	E	F	G	H	I
		10 Student	9	540	4	6	7
		11 Student	10	600	5	9	6
		12 Student	8	480	4	9	10
		13 Student	10	600	1	9	7
		14 Student	10	600	2	8	7
		15 Student	10	600	6	9	8
		16 Student	10	600	8	9	9
		17 Student	9	540	9	8	7
		18 Student	9	540	7	9	9
	Average		9.611111111		5.333333333	8.111111	8.333333
		19 Physical Planner	9		10	6	10
		20 Physical Planner	8		6	5	8
		21 Physical Planner	9		5	6	9
		22 Physical Planner	10		7	7	9
		23 Physical Planner	7		10	8	10
	Average		8.6		7.6	6.4	9.2
		24 Surveyor	6		6	6	9
		25 Surveyor	7		7	8	9
		26 Surveyor	8		8	8	9
		27 Surveyor	9		8	8	8
		28 Surveyor	7		10	6	10
	Average		7.4		7.8	7.2	9
		29 Architect	9		5	8	8
		30 Architect	9		4	9	9
		31 Architect	10		9	7	8
	Average		9.333333333		6	8	8.333333
		32 Civil Engineer	8		7	7	8
		33 Civil Engineer	9		7	6	8
	Average		8.5		7	6.5	8

	Average Time		Average	Average Answers					
Proffesion	Task 2D	Task 3D	Cobined	Task 2D	2D (%)	Task 3D	3D (%)	Average combin	
Students	9.60	8.10	8.85	5.30	53	8.33	83	6.82	
Planners	8.60	6.40	7.50	7.60	76	9.20	92	8.40	
Surveyors	7.40	7.20	7.30	7.80	78	9.00	90	8.40	
Architects	9.30	8.00	8.65	6.00	60	8.33	83	7.17	
Engineers	8.50	6.50	7.50	7.00	70	8.00	80	7.50	
Other	8.50	7.75	8.13	7.25	73	8.75	88	8.00	98.4
	8.65	7.325							