# Strategic Positioning of Marketplaces and Learning Institutions As Digital Village Centers for Rural Empowerment and Development in Bondo District.

George OdungaObare[1], Dr Patrick OdhiamboHayombe[2], Prof. KefahRabah[3]

| ARTICLE INFO | ABSTRACT |
|---|---|
| | Digital villages have been identified in Kenya as a solution to internet access problems for the rural areas. However, locations of digital villages with respect to community access was a subject of study in this work. The author set out to illustrate that Digital Villages like other social service centers requires centrality and spatial equity in order to optimize accessibility by community members. Studies have shown that the initial cost of setting ICT internet infrastructure for digital villages is very expensive and this has kept most learning institutions and marketplaces almost entirely inaccessible especially in the rural areas of Kenya. This research has made efforts assess the infrastructure that supports the Digital village services in Bondo District. The central aim was to identify hotspots and suitable areas in the district that can serve as convenient sites for digital villages. Geographical Information System Arc GIS 10 and Multi Criteria Decision Analysis tool; Analytical Hierarchy Process has been used to create suitability maps. Ranking of infrastructure of learning institutions was used. The first step utilized infrastructure ranks based on International Union indicators of ICT access for education. Suitability maps were then developed showing optimal prediction areas for location of Digital Villages in Bondo District. Site maps of marketplaces and Learning Institutions were prepared and analyzed using Geographical Information System. Spatial Analysis tools namely; Buffering, Map Overlays and point Interpolation as proximity tools were used to assess the Spatial Qualities of Potential Digital Village Sites. Results reveal that certain institutions are more strategically positioned than others hence more suitable. Spatial Analysis was done based on three divisions namely Maranda, Nyang'oma and Usigu. Most suitable areas falls around Maranda high school, Bondo University and Nyang'oma Technical Institute. The study recommends an integrated policy framework customized to the needs of Bondo District that can stimulate infrastructural development, encourage Public Private Participation, create Community Awareness towards the use of Digital Villages to stimulate socio economic development of the area. |

## 1.0 INTRODUCTION

Information and Communication Technology (ICT) is the world's fastest growing economic activity (GoK, 2005). The sector has turned the globe into an increasingly interconnected network of individuals firms, schools, and governments communicating and interacting with each other (GoK, 2005). Despite the global economic downturn, on the whole, the ICT sector has continued to grow, in large part due to continued growth in emerging markets (ITU, 2011). The environment for ICT access has improved relatively rapidly in most urban areas of Africa. Years ago only a handful countries had rural access to internet.

Demand for internet based information has risen more than ever and countries are making serious efforts to get updated with the latest technological changes relating to advancement in ICT. The rapid growth in ICT is evident from the fact that while it took the telephone close to 74 years to reach 50 million users, it took

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[1] Masters Student(2010-2013) JaramogiOgingaOdinga University of Science and Technology.
[2] First Supervisor, JaramogiOgingaOdinga University of Science and Technology.
[3] Second Supervisor, JaramogiOgingaOdinga University of Science and Technology.

the worldwide web (www) 4 years to reach the same number of users (Langmia, 2005). ICT has opened new channels for service delivery in areas as e-government, e-education, e-commerce, e-health and general information dissemination. Despite the rapid growth of ICT sector the Digital Divide is still at its most extreme end in most African countries and especially in the rural areas. Internet penetration was over 600 percent for the seven year period; 1997 to 2004 (Shea, Timothy, Godwin Ariguzo and Steven, W. 2006).
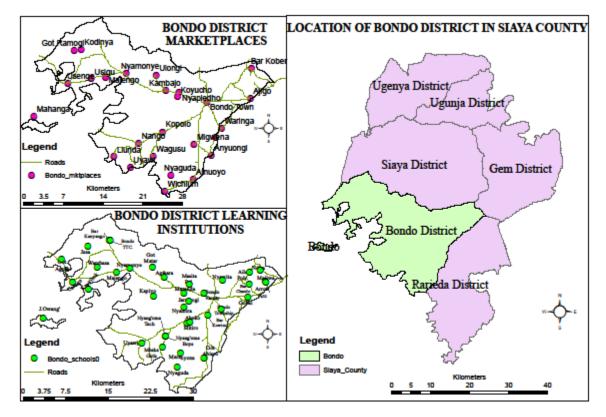
A substantial gap still exists between countries and regions. Digital villages have been identified to be a solution to the internet access problems especially in the rural areas where the internet infrastructure is very low. It is one way that Governments and the private sector have devised as means to coping with the rising demand for information needs of communities. The Digital Villages project is meant to assist the Government to check the digital divide and improve rural urban accessibility to ICT services especially the internet.

## 1.2 Study objectives
1. To assess the existing ICT infrastructure that supports Digital Villages in learning institutions and marketplaces in Bondo District.
2. To establish whether marketplaces and learning institutions are strategically located to be used as Digital Village Centers.
3. To propose suitable locations that can be used for the development of digital villages.

## 1.3 Study Area
Figure 1.0 Map of Study area.



Source : Author (2013)

This study was done in Bondo District (figure 1.0) which is located in Siaya in Kenya. Geographically Bondo district lies between (0° 26' 00'' S, 33° 58' 00''E) and (0° 90' 34° 35' 00''E) latitudes and longitudes respectively. It has a total area of 1,328 km² of which 577.2 km²is land surface, while 751 km² is covered

with water of Lake Victoria(NEMA, 2007).Topographically, the District has few scattered hills namely Usenge and Got Ramogi in Usigu Division and Got Abiero hill in Nyang'oma division(UN-HABITAT, 2008).

Bondo district has a warm and a humid climate. Bondo Town serves as an administrative unit with all the government departments centralized at Bondo town. Three divisions are Nyang'oma, Maranda and Usigu Divisions. Bondo district has a population 157,522 persons of who 76,468 are males and 81,054 females. Number of households is 37,296 (GoK, 2009). According to a report by the (GoK 2008-2012), a total of 41,128 people are living in urban areas and the population is set to increase to 44,206 people by the end of the plan period. Maranda division has the highest population of 58,477 compared to Nyang'oma division which has the least with 43,353 people (GoK Census, 2009). Cultural heritage, agriculture, livestock, fisheries and tourism are among the most active socio-cultural avenues.The district has a total of 133 primary schools, 24 secondary schools and 6 tertiary institutions.

## 2.0 LITERATURE REVIEW

### 2.1 Bridging the Digital World
Chen and Wellman (2004) maintains that despite the explosive growth of the Internet access and use, a disproportionate number of internet users are still concentrated in developed countries especially the United States of America. The G8 countries like Canada, France, Germany, Italy, Japan, Russia, the UK and the US are still home to almost 50% of the world's total Internet users. This happens even though they constitute just 15% of the world's population (WSIS, 2005). Discrepancies in international Internet bandwidth are higher because developing countries have to pay high cost of link to a hub in a developed country (WSIS, 2005). Access to appropriate technology is costly and inaccessible to most rural areas in the developing world.

The World Economic Forum report (2002) on the global digital divide indicate that 88% of all Internet users are from industrialized countries that comprise only 15% of the world's population (Pick and Azari, 2008). Eight year later studies by the International Telecommunication Union reports that in 2010, more than 2 billion people are using the Internet (ITU, 2010). While Internet penetration reached an estimated 71 per cent in 2010 in developed countries, the penetration number lagged behind at just 21 per cent in developing countries (ITU, 2010). Broadband access which empowers much of the advanced multimedia and graphically rich content that defines the Information Society remains largely confined to Internet users in developed countries by 2010 (ITU, 2011). This is a pointer that Africa and other third world countries require assistance to bridge this divide especially for rural areas. People around the world have accepted the idea that the internet is not only useful but perhaps even essential (ITU, 2011).

Kenya aspires to achieve the status of a knowledge and information-based society by 2030 (GoK, 2007). This aspiration is linked to the growth in the global business outsourcing industry that has opened a new window for developing countries to exploit a new growth area for ICT Enabled Services (ITES) and Business Process Outsourcing (BPOs). ICT has become a key driver of Kenya's economic growth over the last decade accounting to 13 per cent of growth in Gross Domestic Product (GDP). E-Government in Kenya has been one of the main priorities of the Government of Kenya towards the realization of national development goals and objectives for Wealth and Employment Creation, as stipulated in the Kenya Vision 2030. The Government of Kenya established the e-Government Programme in June 2004. It has since then committed itself towards achieving an effective and operational E-Government to facilitate better and efficient delivery of information and services to the citizens.

Digital Village concept in the country was initiated by the establishment of the Kenya ICT Board (KICTB) as a state corporation under the State Corporations Act Cap. 446 on 19th February 2007 (Adeya and Waena, 2010). The Kenya ICT Board's mission was to champion and actively enable Kenyans to adopt and exploit ICT through promotion of partnerships, investments and infrastructure growth for socio economic enrichment. Its vision is to make Kenya a top ten global ICT hub by 2030. In efforts to promote digital inclusion in all learning institutions of the country KICTB established 'Wezesha' a laptop ownership initiative for university students across Kenya. This initiative supported the attainment of Kenya's Vision 2030 through ICT. Under 'Wezesha' which means 'enable' in Kiswahili, university students in participating public and private universities and colleges were eligible for a price reduction on the purchase of a laptop. This has empowered students to get better equipped to carry out research and complete assignments (KICTB, 2012).

Locally, joint efforts of the private and public partnerships are taking the lead in the rolling up of digital villages. The World Bank through the KICTB is working on the Community Broadband initiative to boost the status of ICT infrastructure in the country. Regional Infrastructure Project (RCIP) is to help beef infrastructure in rural areas especially the internet. Ciscos Internet Solutions Group (CIBSG), The Kenyan Digital Opportunity Trust (DOT), IBM and Non Governmental Organizations (NGOs) like Kenya Data Networks (KDN) are working with the KICTB to help accelerate internet access to various parts of the country. Telecommunications companies Safaricom and Airtel are taking measures to compliment rural connectivity through mobile broadband. Despite all these reports from studies commissioned by the KICTB, there is inadequate coordinated approach to Digital Village planning, services, content and core technical issues. Initial phases of Pasha Centre project began by training of Pasha Managers who were found to lack technical skills to manage the digital village centres (KICTB, 2012).This study therefore compliments the Governments' ongoing efforts to provide best strategies of success for Digital Villages through Strategic Positioning of Digital Villages in Bondo District. The Strategic Positioning of Digital villages is envisaged to provide future access to e services and improve socio economic potential for rural areas of Bondo District.

## 3.0 METHODOLOGY

Survey was carried out in all the 36 secondary schools 6 tertiary institutions and 24 market places in Bondodistrict.ICT infrastructure were assessed using observation and infrastructure checklist and later ranked. Objective two entailed a participatory process involving selected  stakeholders who were mainly teachers from the tertiary learning institutions to compare criteria used for decision making using Analytical Hierarchy Process (AHP) to generate criteria weights. These weights were then used to create suitability maps in Acrgis environment. An overall weighted overlay map was developed to help visualize areas strategic enough for digital villages. Spatial statistics, buffering, and interpolation were used to help in predicting suitable strategic locations for digital villages.

### 3.10 Rank Transformation
This technique was used to analyze the level of existing ICT infrastructure that supports Digital Villages in Bondo District. A set of ICT infrastructure indicators were used to rank learning institutions in ascending and descending order in SPSS environment against a set of ICT infrastructure indicators. These results of the ranks were then summed up to compute a Composite Rank (CR)[4] which was used to identify the most strategic and potential institution in terms of ICT infrastructure. An institution with the highest CR score was selected as the most suitable location for a digital village. Composite Rank was considered favorable because it presented a cumulative effect of individual set of variables to the overall site selection process. Ranking of the Learning Institutions was based on ICT infrastructure indicators as guided by the International Telecommunications Union (ITU, 2010).

Composite Rank = Sum of Individual Infrastructure Rank Scores
$CR_r = RAI_r + TAI_r + L_r + ITR_r + PRJ_r + CNR_r + E0_r + TR_r + IQS_r + P_r + CL_r + PLN_r$
Whereby;
$RAI_r$=Radio Assisted Instruction (RAI)

$TAI_r$=Television Assisted Instruction (TAI)
$CNR_r$=Computer  Number Rank
$IT_r$= Institutional Telephone Rank
$P_r$=Photo Printers/Photocopiers
$PRJ_r$=Projectors
$L_r$=Laminators
$CL_r$= Computer Laboratory
$EO_r$=Energy /Power
$TR_r$=Type writer
$IQS_r$=ICT Qualified Staff
$PLN_r$=Population

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[4]CR  refers to the sum of individual ranks. This is a way of determing the cumulative influence of individual infrastructure ranks.

### 3.2 Digital Village Location Suitability Analysis using Analytical Hierarchy Process(AHP)

AHP as a case study has been used in ecotourism studies in Thani province in Thailand in turn considerably facilitated the creation of land use suitability maps for his site selection process. (Marimoni, 2004) conducted similar studies in the republic of Iran. Lamelas et al., (2008) argued that this is an additional benefit of integrating additional geo scientific aspects in land use decision that is as demanded by agenda 21 on sustainable development.

Research work on AHP as a methodology of ranking criterion seems to be on the increase despite the methodology being proposed many years ago. Bukenya (2000) employed six different criteria as number of species, wildlife management potential, endangered species, potential to attract more tourists, less susceptibility to encroachment and degradation over long period to prioritize the national parks in Uganda. Ok (2006) used spatial multi criteria analysis in the selection of ecotourism conservation planning sites in Ignaeda. He used a total of 19 alternatives with 28 criteria based on the Electra method. However Kumar (2010) used MCDM to create an index called Ecotourism Potential Index(EPI) which comprised a set of indices as wildlife distribution index, ecological value index, and environmental resilience index and ecosystem diversity index in order to prioritize ecotourism sites in Sikkim in India.

Most planners and researchers often referring to AHP as the Saaty weights (Saaty1977; Saaty and Vargas, 2001).It is a decision support tool that can be used in solving complex decision problems. It uses a hierarchical structure of objectives, criteria, sub-criteria and alternatives. AHP is based upon three principles namely decomposition of the overall goal (suitability), comparative judgment of criteria and synthesis of priorities (Arabinda 2003; Baniya,2008).It uses a scale of absolute numbers to express individual preferences or judgment as shown in the table below for a comparison involving three factors. Strength of agreement or disagreement with the comparison in the range of 1-9.

**Table 1.0: Weighting Score sheet**

| Factor | Factor Weighting Score | | | | | | | | | | | | | | | | | | Factor |
|--------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|--------|
| | More Important than | | | | | | | | | | Less Important than | | | | | | | | |
| C1 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | C2 |

Adopted from Khwanruthai, 2012.

In this scale of 1- 9 criteria relative response by choice of comparisons can be made as follows,

**1-2** = Equal     **3-4** = Moderate
**5-6** = Strong     **7-8** = Very strong
**9** = Extremely strong association

Following this pattern the pair wise comparisons would be made by the numbers namely 1,3,5,7 and 9 respectively. The converse is also true decision which is the reciprocal of the sequence and is given by, 1/3, 1/5, 1/7 and 1/9 respectively. The whole procedure would involve four processes namely model specification, pair wise comparison of the factors, weighting of alternatives and investment ranking. A consistency index is calculated from the normalized Eigen vectors generated by the factors/criterion. Saaty (1977) developed a reference table of randomized consistency indices based on the number of criterion s shown below.

**Table 2.0: Random consistency Index**

| n | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|------|------|------|------|------|------|------|------|
| RCI | 0 | 0 | 0.58 | 0.90 | 1.12 | 1.24 | 1.32 | 1.41 | 1.45 | 1.49 |

Random Consistency Index (Saaty,1977).
Whereby;
**n** = number of criteria
**RCI**= Random Consistency Index.

Thereafter raster maps are prepared which represent the weights as determined by the diverse criterions.

## 4.0 RESULTS AND FINDINGS

### 4.10  ICT Infrastructure Findings in Learning Institutions in Bondo District.

ICT survey in Bondo district revealed disparities on the levels of ICT infrastructure in learning institutions and marketplaces in Bondo. Few centers have access to computer infrastructure and internet facilities. Many reasons are contributing to this disparity. One of the reasons is that the government has not adequately made efforts to solve problems of rural connectivity. Until 2004, when the government realized the potential of ICT to cause socio economic development, many years have passed without relevant legislation in place that can spur internet infrastructure in rural areas. In addition there hasn't been a clear picture of public internet infrastructure plan for Bondo district. To date there is no elaborate internet plan for learning institutions in the district. The National Optic Fiber Infrastructure (NOFBI) has not reached Bondo District to provide faster and reliable internet connections. However the cost of fiber optic is still too high for majority of rural residents and institutions.

Many computer laboratories have limited computer internet network infrastructure in place. ICT hardware doesn't feature prominently in most Secondary' Schools' annual budgets. The Ministry of Education donated computers to Secondary Schools like Maranda High School, Nyamira Girls, Gobei, Usenge High School, Nyamonye Girls and Majengo Sec. School among others in the district. It is reported that many schools have no trained staff to handle computers and internet. Some head teachers are untrained on modern ICT and internet and are adamant in implementing decisions that promotes ICT in their respective stations. Some head teachers feel that the budgetary provisions are so high that is out of their institutions' ability to finance.

Survey established that in certain instances insecurity has provided a challenge to computers already purchased in some institutions. Theft and breakdowns by students have misused ICT facilities due to lack of an elaborate maintenance scheduled. Viruses spread very fast over the computers in learning institutions due to lack of periodic updates that require internet connection.

The study established that more than 80% of secondary learning institutions have access to electric power. This is a boost to the overall ICT programme for digital villages. Presence of electric power offers an excellent opportunity for the setting the digital village centres. No learning institutions in the district has infrastructure in place for alternative green sources of energy. The Rural Electrification Authority (REA) programme has helped accelerate connection to the national grid. The Republic Kenya has a policy provision that allows all secondary schools in the republic access to electric power through the mains supply under medium and low voltages of up to 415V. Currently, only two secondary schools in the district have no power connection. However, there is lack of an elaborate plan for renewable sources of energy and emergency power supplies in the district institutions including marketplaces. There is a lot of exposure of solar radiation which is not used in any institution. Institutions often work on standby generators to power schools operations in case of power failures. The study observed rampant power loses in the district yet most learning institutions lack elaborate emergency power supply plans in place.

The study noted wide use of the second hand computers with very old monitors is rampant in learning institutions. The situation even though desirable may not be very healthy for the rural areas because some of these computers consume a lot of power. In most cases they get to learning institutions as donations in aid by NGOs and other parastatals (IBM, 2010). These second computers are often limited in their ability to run modern applications software due to the nature of their hardware configurations. These computers are donated at no cost most Learning Institutions have a preference to them. These types of computers often emit stray radiations which in most cases are harmful to the eyes.

The ratio of Students to Computers in Bondo district as at is now, can only be described as very low.The ratios of computers to students and Internet-connected computers to students are varying in the range beyond 1:10 and more. In some institutions it goes beyond 1:50 and others more than 1:150. Such institutions with high ratios has never got donations or purchased computers at all. Their basic ICT infrastructure is restricted to the major offices in the administration blocks. The computers are often slow and serve limited number workstations. Internet costs are high hence not sustainable except for Bondo University which has internet subscriptions for its students and staff. Based on the observations above it is true that the infrastructure available in many institutions cannot meet the information needs of these centers to effectively discharge digital village services.

Lack of a strong regional backbone ICT internet infrastructure that provides full interconnectivity amongst rural districts at the sub-regional and regional levels is a hindrance towards the full realization of the world information society (Catherine, 2009). More than 75% of the learning institutions doesn't have internet infrastructure while 86.1% does not have any Internet Service Provider to offer internet services. Network security infrastructures are missing in entirely all learning institutions. Internet firewall is mainly restricted to the Microsoft Windows application. There is no dedicated web service that can maintain, control and manage security compliance across almost all learning institutions. The use of antivirus is of the trial versions of Avast, Avira or Mcafee. In most learning institutions the antivirus often stays un- updated due to lack of internet connections for years.

This study realized that more than 90% of the learning institutions in all categories lack additional computer and ICT peripherals like multimedia headphones, CD writers, fax machines, printers, photocopiers, laminating machines. Projectors are owned by few national and provincial learning categories. When all the learning institutions were subjected to infrastructure rank analysis, there emerged different trend showing a remarkable growth in ICT and computer infrastructure in certain learning stations. BUC, Maranda High Schools, Nyamonye, Nyamira, Usenge, Got Abiero, Nyang'oma Technical Training Institute, Majengo and Arrow Arc Kenya in Majiwa featured as some of the institutions who have started showing development in their ICT infrastructure. The rest of the institutions are at different levels of development and each institution has its own specific infrastructure needs. Following these varied disparities and there is need for elaborate plans for the supply of computers and internet in learning centers and market places where people can meet.

## 4.20 Suitability Analysis results through AHP.
### Table 3.0: Factor Scores

| Factor | Roads | Markets | Population | Computers | Learning Institutions | Power Sources |
|---|---|---|---|---|---|---|
| Roads | 1.000 | 0.333 | 0.667 | 0.667 | 0.333 | 0.500 |
| Markets | 3.000 | 1.000 | 2.000 | 0.333 | 1.000 | 1.000 |
| Population | 1.444 | 0.500 | 1.000 | 1.000 | 1.000 | 0.500 |
| Computers | 1.444 | 2.750 | 1.000 | 1.000 | 2.500 | 0.667 |
| Learning Institutions | 3.000 | 1.000 | 1.000 | 0.500 | 1.000 | 0.667 |
| Power Sources | 2.000 | 1.000 | 2.000 | 1.444 | 1.444 | 1.000 |
| **Sum** | **11.888** | **6.583** | **7.667** | **4.944** | **7.273** | **4.334** |

Source: Author ,2013.

Table3.0 shows the mean factors of the stakeholder opinions comprising of teachers selected from within the schools to compare roads, market places, number of computers, learning institutions and power sources as selected spatial and non spatial factors for site selection. From the weight factors normalized eigen vectors were generated shown in table 4.0.

### Table 4 .0: Normalized Eigen vector values
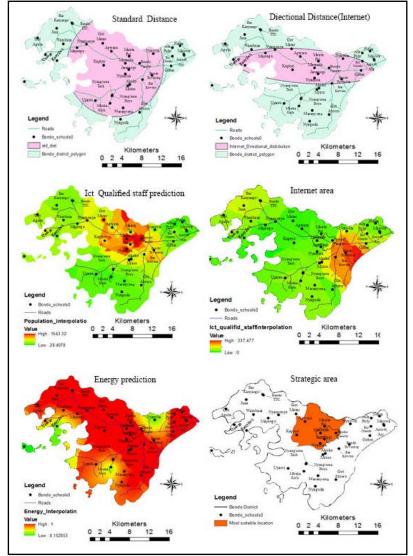Source : Author, 2012.

| Factors | Roads | Markets | Population | Computers | Learning Institutions | Power sources | Weights |
|---|---|---|---|---|---|---|---|
| Roads | 0.084 | 0.051 | 0.087 | 0.135 | 0.046 | 0.115 | **0.518** |
| Markets | 0.252 | 0.152 | 0.261 | 0.067 | 0.137 | 0.231 | **1.100** |
| Population | 0.121 | 0.076 | 0.130 | 0.202 | 0.137 | 0.115 | **0.781** |
| Computers | 0.121 | 0.418 | 0.130 | 0.202 | 0.344 | 0.154 | **1.369** |
| Learning Institutions | 0.252 | 0.152 | 0.130 | 0.101 | 0.137 | 0.154 | **0.926** |
| Power source | 0.168 | 0.152 | 0.260 | 0.292 | 0.198 | 0.231 | **1.301** |

The results were entered into an excel sheet that assisted in the computation of the of the relative suitability indices from the selected participants. Consistency ratio was determined by calculating the ratio between

the normalized eigen vector values and the number of criterion.Roads the weight was realized as 8.6%, Population of Learning institutions =13.1%, Number of computers = 23.5%, Distance from marketplace =18.1%, Power source or Energy=21.5% with CR of 6.8%. The ratios were then used to create suitability map shown in figure 2 as a result of weighted summation in arcgis spatial analyst.

**Weighted Sum** = (Distance from Market Place*0.181) + (Distance from Main Roads*0.086) + (No.of Computers * 0.235) + (Source of Energy * 0.251) + (Population of Leaning Centres * 0.131) + (Distance from Learning Centres * 0.131)

Figure 2: Maps showing spatial distributions and sampled prediction surfaces.



Source: Author ( 2013)

The percentage weighting as used in the map overlay sum were generated through the weighted summation method in Arcgis toolbox of spatial analysis. Above raster maps illustrates some of the prediction surfaces generated as a result of the process. The standard distance map for the district learning institutions shows a mean central circulor region of radius 10 km (Figure 2). It is evident that a majority of schools can be accessed around this central mean distanceof 10 kilometres. At close proximity to the centre is bondo university and Maranda high school.The results of the final weighted overlay map shows that suitability area falls in the region marked with a red inking. The standard elliptical tool also provides an indicator that internet distribution is majorly located in this area. In the suitability map red regions represent the most

ideal locations for a digital village service. It can be observed that this areas falls closer to Bondo town with a number of secondarry schools in the district at a given radius from the central feature.Some of the schools in the immediate neighbourhood includes Maranda School,Jaramogi Oginga Odinga and Nyamira girls.The levels of suitability transits from red at the highest to yellow at moderate and eventually to shades of green at the least suitable areas.

In order to propose the most appropriate location for a digital village facility, buffering as a proximity analysis tool was carried out on the point maps. Variable buffering technique was used to create the polygons of various diameters. Various buffer distances were experimented with and eventually buffer a radius of 10Km was foundto be most convenient to ensure accessibility to most institutions in the district. Accesssibity to designated schools and marketplaces was analysed using circulor buffers ( figure 3.0).
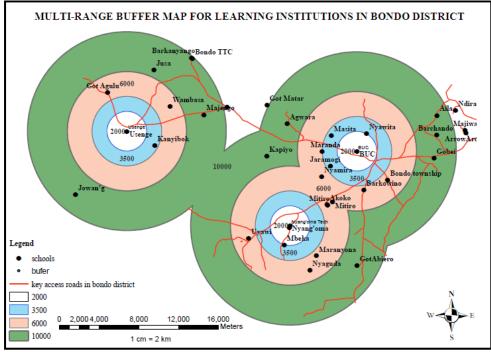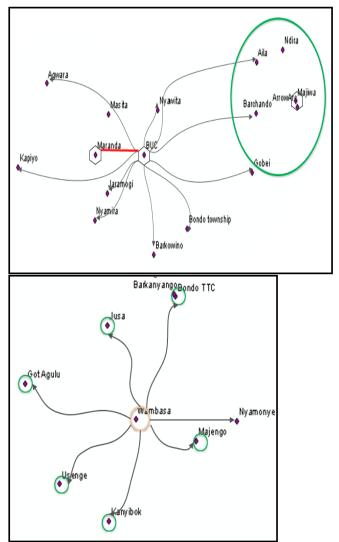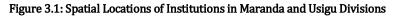
Figure 3.0 : Buffer distances from selected Learning Institutions



Source: Author,2012.

The study developed various buffer maps from the potential learning institutions in the district in an effort to establish the best centralized locations for digital villages. The principle of centrality, threshold and range were used as guided the selection. Bondo University College, Nyang'oma Technical Traning Institute(NTTI) and Usenge high school in Usigu division were used as the centroid of the buffers. The study of buffer maps reveals a triangular pattern formed by institutions in each division. Figure 3 indicates distances between NTTI and USENGE as 19Km, Usenge and BUC to be 22Km and BUC and Nyang'oma as only 10Km.At a distance of 2Km from each station BUC, NTTI and Usenge can access 3, 2 and 2 other learning institutions respectively. At 6Km each institution can access 7 centres each. However at 10Km BUC can access 13, NTTI can access 12 while Usenge can access 12.However with the selected centroids there were still other institutions which were outliers.

**Figure 3.1: Spatial Locations of Institutions in Maranda and Usigu Divisions**



Source: Author (2012).

## 4.30  Discussion of Results

It was observed that Maranda has the highest student population of 1700 Compared to Bondo University's 1500. However; the number of ICT qualified staff featured very strongly at Bondo University (BUC) compared to the rest of the institutions. The argument presented with population was that an institution with the highest population has the highest ability to reach many people or can serve wider parts of the district than institutions with low population. Such institutions were ranked higher based on student population. Usenge High School despite scoring well in the infrastructure rank showed a non spatial centrality and can only be access few institutions in its neighborhood of Usigu division. Its proximity to the marketplace at Usenge town presented it with an opportunity for faster development that would give the school a higher community interest and rating. However, Usigu market place is more centrally located in Usigu division and at close proximity to many neighboring institutions including marketplaces within the division.

Fr.JoakimOwan'g Secondary School in Mageta is an institution that requires infrastructure up scaling in the region interms ICT infrastructure. It is located in Mageta Island which is a hub of commercial activities with a number of many government institutions existing in a small island in lake Victoria. Despite Mageta Island

strategic location, it doesn't have any telecommunications facility as well as electric power. Mageta is densely populated island that is served by a ferry service with many beach landing points; the island requires digital villages service more than any place in Bondo district. It is for this reason that the study found it necessary to improve Mageta Islands in terms of ICT and Digital Villages services. Buffer analysis reveals that at a distance of 10km the internet network can reach Mageta if located at Usenge which is the only ferry landing point from the island. However, the position of Fr. Owan'g Secondary school would provide Unique Location Advantages (ULA) to the adjacent islands and landing beaches in that particular region. The spatial quality of Mageta Island as a destination for global business through digital villages cannot be underestimated in Usigu division.

BUC is the only university in the entire district located in Maranda division. It has its own Unique Selling Points (USP's) in the region as far as marketplace issues and ecotourism activities are concerned. The ICT School of Informatics and Innovative Systems of BUC is growing each and every day with students being admitted into various ICT disciplines. The university serves a wide geographical region with most of its campuses planned at various stations in the district. Proposals are at advanced stage to create a campus at Port South Bay Beach. With internet facility at Miyandhe campus the possibility of this trickledown effect to the local fishermen and local business is very high (Mistra Urban Ecotourism Report, 2012). Bondo University enjoys a number spatial location advantages including being served directly by a tarmaced road from Kisumu that links Osieko to Uganda directly. Transport infrastructure is most developed in this region giving the university as a centre of excellence for education and higher training. The very many students admitted at BUC need internet and online course materials through the digital village concept.

Bondo University had the capacity to employ both human and economic resources to decentralize internet and computing service to smaller institutions within its threshold. The university has the ability to hire the right trained personnel to manage this digital village service. Bondo University is believed to have a higher spatial quality in the region compared to all in internet and Digital Village accessibility. Buffer maps with BUC as a centroid has the ability to link more than 18 learning institutions in its immediate neighborhood.

St.Joseph Nyang'oma Technical Institute has been proposed as a potential digital village centre for Nyang'oma division because of its central location in the division. The centre can be accessed by a number of institutions on an equal measure. Spatially, the institute is more centralized as compared to Got Abiero which is an outlier institution at close proximity to Rarieda District. In terms of Infrastructure Nyang'oma Technical is on the upward trend with an internet facility already installed using a wireless technology. The institute trains students in ICT up to diploma levels. Nyang'oma Technical is surrounded by a number of institutions totaling to six namely Nyang'oma Boys Secondary School, Nyang'oma Technical Training Institute, Nyang'oma Girls Boarding Primary School, Father Audra Secondary School for the Deaf, St Ann's Mission Dispensary, Franciscan Sisters of Annas' Convent, an Orphanage and a Catholic Parish Church.

In addition Kopolo Marketplace, Nyang'oma Marketplace, Nango and Wagusu Marketplaces are at a distance of less than 2km from Nyang'oma Technical Training Institute. The centre requires an ultra modern digital village in this region is necessitated by the needs of the local institutions. The headquarters of Nyang'oma division is based at Kopolo which is at close proximity to Nango and Nyang'oma Technical Training Institute. With the location of a digital village in this place, government services will be delivered faster to the locals.

An alternative location that require up scaling of infrastructure is Mbeka Girls Secondary School. This is a unique institution being the only girls' day secondary school in the district. At its formative stages the institution suffers from a lot of infrastructure needs from modern classrooms to power and teaching staff. The student enrollment in the institution which is at its third year is gradually increasing and efforts are required by the stakeholders to empower the girl child education in the region. Mbeka Girls Secondary School is located in an area where fishing is the main predominant economic activity and majority of the day school going girls needs alternative sources of empowerment to make correct life decisions. A digital village positioned at Mbeka Girls would easily serve a number of ecotourism outlets. Nango Marketplace is also found in Nyang'oma Division. It is a fast growing marketplace in the regions a viable market destination for ecotourism.

As an administrative centre the population of Nango marketplace is increasing fast. Notable ones include a health centre, a cyber café because Nango directly links to more than three of the biggest beaches in Bondo district. Oyamo Island, Ndeda and Sifu Islands on the lower parts of the district links to Nango directly. The

islands have daily fishing businesses and ecotourism related activities. People in the islands require Government information relating to health, education, commerce, administration, lake safety, security and weather information which can be brought in through strategic locations of digital village centers at close proximity with the beaches.

## 5.0 CONCLUSION AND RECOMENDATIONS

### 5.10 Conclusion
The study of the spatial location of a community facility is a very important subject that requires the input of all the stakeholders in its design and adoption. This study made deliberate attempts to unravel how infrastructure among other variable affect the selection of a project location in an area. The study noted that the cost of infrastructure is very expensive and needs to be shared by various social institutions. More affected is the internet infrastructure. A number of social institutions like learning institutions and marketplaces are still struggling to put up basic infrastructure for digital villages. It emerged very clearly that a number of learning institutions especially the district schools need assistance to set up basic internet infrastructure. Islands marketplaces are worst hit in the region and needs uplifting.

The study observed that there are immense untapped potentials bestowed on the available institutions in the district. A number of schools and marketplaces were central enough to be used as strategic locations for digital villages. Bondo University College, Nyang'oma Technical Training Institute and Usigu Market place were some of the best strategic locations to be centres for digital villages for divisions in the district. However, many of the islands around beaches are cut off in terms of internet access and network coverage by most of the telecommunications companies. This study strongly suggests that there is an opportunity to build infrastructure for the future, that can provide competitive offering and to increase the economic and quality of life of the residents in Bondo district.

### 5.12 Recommendations
Based on the research findings, a number of recommendations are proposed. The recommendations have been classified into two thematic areas namely policy and technical strategies for digital villages in Bondo district.

### a) Policy Recommendations for Digital Villages
Bondo Community requires policies that are supportive in the establishment of more digital village infrastructure and ensure accessibility. Community access is key to the overall success of digital village services. Today access to information is an essential as the right to free primary education, basic healthcare and security. Therefore, more pro-poor policies should be put in place to promote interested parties to erect internet based businesses in the rural areas.

A policy that promotes development and implementation of new and efficient digital village centres with affordable internet pricing is necessary for the district's ICT sector. This policy should encourage and allow for experimentation with new and emerging technologies as well as facilitate the growth of internet networks with open access to the wider population of learning institutions and marketplaces. The district should allow for non-discriminatory practices especially by interested investors regardless of their origin and type in technology. For example, the Local Authority should allocate a budgetary provision for a digital village in each, marketplace within the district.

Bondo County ties through the devolved Siaya County Government should step up efforts to encourage public and private sector participation in the creation of more digital village centres in the district. Policies on project site locations at constituency level, needs to be taken seriously. Locational analysis of ICT projects should equally be subjected to planning standards by qualified staff before implementation to ensure access by the intended people. There is need for clear policy guidelines that determines the location of a digital village facility just like the regulations that vets of building site plans for local municipalities. Site planning and development controls are necessary in the set up of Digital villages. Physical Planning act Cap 286 of the bylaws of Kenya needs a review to incorporate planning standards for Digital Village setups.

A subsidized loaning scheme by the government to interested parties would help accelerate the rate of digital village penetration in the rural areas. Focus should be placed on research on strategic positioning of

which may vary from region to region in order to achieve optimization of digital facilities. In the past the Government issued funds to prospective digital village owners as startup capital through Family Bank without due consideration of the spatial equity of regions as well as customer spatial distribution. A realistic loaning scheme should be availed to the interested parties in a manner that repayment rates are not too high. Subsidies given to people to utilize the locally available resources and provide local materials contents online could help promote digital village growth. Aspects of culture and heritage relating to particular region especially in Bondo district needs to be packaged online to motivate people to patent on what they are good at. These patents with legal rights and would encourage earnings. It is only when a community put their products online that they get the motivation to be part and parcel of the internet process.

Effort should be made by the Ministry of Information and Communication Technology to zero rate taxes on computer related infrastructure. Subsidies should be given to the private entrepreneurs who would want to invest in the technologies that would ensure internet access to rural areas. This should be supported by relevant policies and legislations that would ensure all the 47 counties receive appropriate grants in aid to help erect more internet infrastructure. The Government through the Ministry of Education needs to create a funding kitty for learning institutions to support ICT infrastructure projects for counties, various divisions and learning institutions. Supportive programmes like one laptop per child should be intensified by the County government should promote acquisition of laptops computers by the locals. Policies on grants should not be punitive as the current exiting pasha platform where loans are given through commercial banks with high interest rates and repaid on fixed schedules on monthly basis.

## b) Technical Strategy for Digital Village Service

Following results of accessibility analysis, it is necessary that a network plan that would ensure equitable accessibility needs to be put in place for the district learning institutions and community. This study proposes that a wireless network plan permeating all corners of the district would be necessary probably through the broadband technology. Three aerial masts should be erected at different locations per division forming a triangular set of antennae (Figure 3). This should be fitted with microwave enable point to point line of sight dishes that can ensure efficient and faster signal propagation in the district. The design and spatial location details of the antennas would ensure reliable internet network access by all potential marketplaces and learning institutions in the district.

Based on the results of the survey and buffer polygon maps, the radio antennae's masts for the internet network could be erected at Gobei in Maranda Division, Usigu in Usigu Division and Got Abiero in Nyang'oma Division. The antennae network distances according to the buffer maps could be approximately equalized. This would ensure adequate network propagation in the district.

At the backyard of the triangular set antennae, a fully functioning telecommunications infrastructure that should allow for internet service access should be established (Figure 3). In terms of implementation schedule, consultations with the relevant education authorities and design engineers are necessary such that donor funding and support can be secured for the purchase of the necessary infrastructure. Different categories of institutions can be enlisted to benefit from the wirelesses network including Early Childhood Schools, Primary Schools, Secondary Schools as well as Tertiary Learning Institutions in Bondo District. The first batch to the programme implementation could include the 30 secondary and 5 tertiary institutions followed by 144 Primary Schools in the second phase. If properly designed, community members would access the wireless networks at designated hot spots for free or subsidized payment to access to web services. Internet based information related to agricultural activities, weather updates; education and security alerts like lake disasters, e-government services, e-health services as well as electronic commerce would be made easily available to the people. People should also access such a wireless network easily through their mobile phones which are internet enabled, laptops as well as other hand held devices. To effectively and efficiently management of both voices, text and video data services a team of qualified technical and maintenance staff would be required to do the maintenance requirements of the project. Financial plan would entail a form of subsidized payment based on a periodic membership fees.

Apart from having designated hot spots where community members can log in freely, primary and secondary schools should be supplied by commercial connection kits containing basic access facilities like a hub or a switch at some subsidized cost. Notable design issues involving powering cost and location of the antennae altitudes. It is important to note that the three chosen places based on the buffer maps have equally higher altitudes and would form convenient points for maximum signal propagation in the District. In addition to getting equipments and materials of the right standards for the Metropolitan Area Network

(MAN), additional server content materials should be developed with relevant needs for the district populace. Weather update reports on the condition of the lake based on the fishing activities that could easily be downloaded through mobile phones. School related content following an established curriculum in the country for schools can easily be accessed by the concerned parties. These web services need to be updated as regularly as possible. Entire regional potentials in ecotourism, agriculture, business and health opportunities would be captured on such server environments.
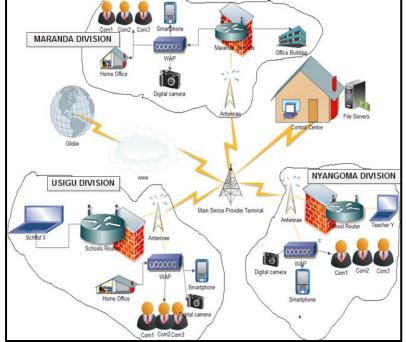
Figure 4: Decentralized Internet Plan for Digital villages Bondo in Bondo District



Source: Author,(2012)

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