Assessment of ICT Infrastructure on ICT Adoption in Educational Institutions: A Descriptive Survey of Secondary Schools in Kiambu County Kenya

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Abstract

Globalization and liberalization have facilitated intensive business competition which in turn has increased the need for adoption of new technologies to increase the efficiency in service delivery. ICT has wide application in public services: in administration, in the educational system, in the health care sector, and in transportation. This study however focused on education sector specifically in secondary schools in Kiambu county in Kenya. Despite ICT efficiency, potential and seamless role in improving productivity and knowledge transfer in social, economic and political pillars of development, it's adoption in High schools in Kenya has remained low and limited. The study adopted a descriptive research design approach and targeted all the public and private High schools in Thika district in Kiambu county in Kenya. The findings shows a positive association between the pace of ICT adoption and high infrastructure costs, pace of ICT adoption and inadequate internet connectivity, pace of ICT adoption and absence of clear policy guidelines in public and private High schools in Thika District leading to low ICT usage causing delay of actual technology integration in schools. This study suggests and recommends that; Basic infrastructure acquisition and support guidelines be availed to schools. Equally the School ICT infrastructure be tax waived or zero rated to address costs of ICT facilities and connectivity to enhance the ICT adoption and improve quality of services and knowledge dissemination through ICT diffusion in High schools and athwart the entire education sector.

Key words: ICT Infrastructure; Information and Communication Technologies; High Schools; ICT Adoption.

Introduction

In most developed countries, pervasive use of ICTs throughout the value chain has contributed to improved performance in firms, enabling them particularly to increase efficiency in combining capital and labour (OECD, 2004).

While there is a wide range of innovations in ICT to support effective and quality delivery of education services and curricula, there is a considerable technology lag in educational institutions. Most institutions still use nearly obsolete systems and are consequently unable to exploit the educational potential of the emerging technologies. This situation is amplified by demands of rapidly evolving skills in a globalizing labor market.

New paradigms are also emerging where by education service delivery becomes: less about teaching and more about learning (less "magister-centric" and more "learner-centric" via self-tutoring and the use of individualized information research abilities); increasingly less confined within the sole geographical location of learners (a country) or less dependent upon a physical space (a classroom for pooling a critical mass of learners together); and more flexible, adjustable to learners' chosen time, with modular curricula no longer constrained by rigidly formatted schooling path or by rigidly predetermined certification goals.

The building blocks of ICTs are the communication processes and infrastructures. ICT refers to information and communications technologies such as computers and the Internet, as well as fixed-line telecommunications, mobile phones, other wireless communications devices, networks, broadband and various specialised devices ranging from barcode scanners to global positioning systems (Singapore:Ministry of Economic Development, 2004). Teaching modes such as e-learning; distance or virtual classes/laboratories and adoption of electronic content delivery system which are critical in meeting demands for higher education and vocational training can only be implemented in institutions once proper technology infrastructure and policy frame work is in place.

While other countries have reported up to 41% integration of ICT to teaching and learning the proportion remains substantially low in Africa, Kenya included (GoK, 2006). Despite having a rich ideological ICT strategy in education, adoption in Kenya secondary schools has proved to be an uphill task due to gaps in her policy and financial constrains. Singapore established four stages for ICT integration in education: first Envision the future, second Develop country master plan, third Implement initiatives and lastly Evaluate and adapt, MOE policy for educational transformational (August 2008). In their first five year master plan 1997-2002 Singapore invested 1.2 billion US dollars that laid infrastructure foundation. In their second master plan 2003-2008 they strengthened integration of ICT in curriculum by establishing standards for students and seeding innovative use of ICT among schools.

Their core policy targets in third master plan 2009-2014 is to strengthen integration of ICT into curricular pedagogy and assessment, to provide differentiated professionals development that is more practice based and models how ICT can be effectively used to help students learn better by aligning syllabi out comes, national examinations and classroom experience (Singapore MOE ICT policy 2008). Other countries like United state has an e-rate that helps connect schools to the internet, with the largest subsidy going to rural and urban poor schools. This system uses similar concept of universal fund as proposed in Kenya ICT policy. E-rate in South Africa is connected with universal service agency obligations. A program in Brazil not only subsidizes connectivity, but also allows for funding for teacher professional development,(Gok 2005) .

Unlike developed economies, Kenya national ICT strategy for education and training, (GoK,2006) is the ministry ICT policy document, whose targets of investing ksh 18 billion within five year plan 2006-2010 included deployment of 28 adequate ICT equipment to 3000 secondary schools, establishing one lab for connectivity and network infrastructure in each school among other targets which are yet to be realized.

Therefore access to basic technological infrastructure is an integral prerequisite in ensuring faster adoption of ICT in high schools.

ICT Models and Theories on ICT Infrastructure and Adoption

Technology acceptance model (TAM)

The Technology Acceptance Model (TAM) is a theoretical model that explains how users come to accept/adopt and use a technological infrastructure. Original TAM was proposed by Davis in 1989. The model suggests that when a user is presented to a new technology, a number of factors influence their decision regarding how and when they will use it. This includes its perceived usefulness and its perceived ease of use. This model adopts well established causal chain of "beliefs, attitude, intention, actual behaviour", which was developed from the theory of reasoned action by social psychologists. In Davis's study, two important constructs are identified; perceived usefulness and perceived ease of use.

The perceived usefulness (PU) is defined as "the degree to which an individual believes that using a particular system/technology would enhance his/her performance" (Davis, Foxall and Pallister, 2002). The perceived ease of use (PEU) is defined as "the degree to which an individual believes that using a particular system would be free of physical and mental efforts". These perceptions predict attitudes toward the system/technology adoption. Then the attitude develops the intentions to use and the intentions cause actual system usage. In many recent studies regarding technology, TAM is adopted extensively. TAM was adopted and showed that it contributes to the prediction of individual usage of technology (Fishbein and Ajzen, 1989).

Perceived ease of use of an infrastructure has a direct effect on it perceived usefulness and both determine the consumer's attitude toward use, which leads to behavioural intention to use the system and actual use of the system (Davis et al, 2002; Lu et al. 2003).

Diffusion of innovation theory

Diffusion of Innovation theory was developed by Roger's in 1995. Rogers (1995:5) defines diffusion as "the process by which an innovation is communicated through certain infrastructure channels over time among members of a social system". An innovation, according to Rogers (1983:11), is "an idea, practice, or object that is perceived as new by an individual or other unit of adoption". The innovation-diffusion model states that an innovation (technology) is passed on from its source to end users through a medium of agents and its diffusion in potential users for the most part dependent on the personal attributes of the individual user.

The model assumes that the technology in question is appropriate for use unless hindered by the lack of effective communication (Negatu and Parikh, (1999:208). According to Rogers (1983), the four major factors that influence diffusion process include; Innovation itself, Communication, Time and Nature of the social system into which the technology is being introduced (Rogers, 1983). VanAkkeren and Harker, (2003:205) argues that media and interpersonal contacts provide information that influences a person's opinion and judgment. The theory comprises four elements:

Invention, Diffusion through the social networks, Time and Consequences. Information filters through the networks and depending on the nature of the networks and the roles of its opinion leaders, new innovations are either adopted or rejected. Rogers further claims that there are five adopter categories that include: innovators, early adopters, early majority, late majority, and laggards.

Interestingly, the five categories follow a standard deviation curve where very little innovators adopt at the beginning (2.5%), early adopters constituting 13.5%, the early majority constituting 34%, the late majority another 34%, finally the laggards at 16%.

Rogers (1995) presented four additional adoption/diffusion theories. Innovation Decision Process theory. Potential adopters of a technology progress over time through five stages in the diffusion process. First, they must learn about the innovation (knowledge); second, they must be persuaded of the value of the innovation (persuasion); they then must decide to adopt it (decision); the innovation must then be implemented (implementation); and finally, the decision must be reaffirmed or rejected (confirmation). The focus is on the user or adopter. Individual Innovativeness theory.Individuals who are risk takers or otherwise innovative will adopt an innovation earlier in the continuum of adoption/diffusion.

Rate of Adoption theory. Diffusion takes place over time with innovations going through a slow, gradual growth period, followed by dramatic and rapid growth, and then a gradual stabilization and finally a decline. Perceived Attributes theory. There are five attributes upon which an innovation is judged: that it can be tried out (trialability), that results can be observed (observability), that it has an advantage over other innovations or the present circumstance (relative advantage), that it is not overly complex to learn or use (complexity), that it fits in or is compatible with the circumstances into which it will be adopted (compatibility).

Review of Empirical Researches on ICT Adoption and Infrastructure

McKay and Brockway (1989) defined ICT infrastructure as the enabling foundation of shared information technology capabilities upon which business depends. They viewed ICT infrastructure as the shared portion of the ICT architecture. Earl (1989) defines ICT infrastructure as the technological foundation of computer, communications, data and basic systems. He views ICT infrastructure as the technology framework that guides the organization in satisfying business and management needs. Duncan (1995) refers to ICT infrastructure as the set of IT resources that make feasible both innovations and the continuous improvement of IT systems.

Developments in ICT Technological Infrastructure have drastically influenced the competitive business environment as proved by the emergence and strengthening of the global economy, and the transformation of industrial economies to knowledge-and-information-based service economies (Laudon and Laudon, 2001). This has in turn encouraged most organizations especially in the developed countries to use computer-based information systems in order to remain competitive. According to Government of Kenya ICT policy (2005), inadequate ICT infrastructure has hampered provision of efficient and affordable ICT services in the country.

There is therefore need to put more emphasis on provision of support infrastructure, such as, energy and roads; supporting software development; Promotion of local manufacture and assembly of ICT equipment and accessories; and Provision of incentives for the provision of ICT infrastructure. Telecommunication infrastructure is a major issue that stands as an impediment to access of information, most people are not able to access digital information due to lack of the necessary infrastructure (GoK, 2007). This has left a bigger part of the population unable to access the digital information hence discouraging the adoption of ICT thus widening digital divide between developed and developing economies as well as between haves and have not, setting classes and levels of learning institutions rather than sink poverty levels and narrow economic gaps.

Learning institution need to enhance and upgrade current technical architectures to accommodate digital materials especially with the rapid changes in technology.

The architecture will include components such as high-speed local networks and fast connections via either fixed narrowband or broadband Internet access, relational databases that support a variety of digital formats, full text search engines to index and provide access to resources, a variety of servers such as Web servers and file transfer protocol (FTP) servers and electronic document management functions that will aid in the overall management of digital resources (Greenstein, 2001).

Digital preservation has also posed a major intricacy to the development and adoption of information systems in schools. Jewell (2001), defined digital preservation as; the planning, resource allocation and application of preservation methods and technologies necessary to ensure that digital information of continuing value remains accessible and usable. Recording media for digital materials are vulnerable to deterioration and catastrophic loss and even under ideal conditions they are short lived relative to traditional format materials. Other teaching modes such as e-learning and adoption of electronic content delivery system and leveraging electronic processing, storing and transfer of information to a wide variety of users or clients" to promote collaborative teaching and learning among educational institutions.

According to Quibria et al (2003) these infrastructural technologies and applications are further broadly classified into three categories namely computing, communication and Internet. The substantial improvements in computing power, speed, storage and overall capacity have boosted the development of knowledge-based economy and the information society. This has manifested in the evolution of new innovations and developments in Software applications, sophisticated hardware and communications tools (SAITIS, 2005). Therefore proper improvement in technological infrastructure will go a long way in ensuring smooth diffusion and utilization of ICT's in secondary schools.

ICT Adoption in High Schools in Kenya

The adoption and use of ICTs in education institutions in developing countries remains very limited despite a decade of large investment in information and communication technologies (Trucano, 2005). Kenya like other developing countries struggles with high levels of poverty and this has an effect on the adoption and access to ICT (OECD, 2004). The initial aim to introduce ICTs in education was primarily at developing ICT skills, the focus has over time shifted to leverage ICTs to address issues of quality and to improve teaching and learning especially at secondary and post secondary levels. However, availability and use of ICTs at various levels is still patchy.

About 1,300 High schools out of more than 6,000 schools have computers, while most schools with computers use less than 40% of the available infrastructure and very few actually use ICT as an alternative method for curriculum delivery. Kenya ICT survey, (2007) observed that many schools teachers are ill equipped to effectively integrate ICT in classroom due to inadequate number of computing infrastructure including computers, communication infrastructure involving telecommunication structures and roads as well as internet connectivity.

This shows a very slow integration pace and may lead to all benefits of ICT's un-equitably realized or not being realized in schools in the near future. Many teachers perceive that adoption of ICT in school will leader them jobless due to it foreseen benefits such as e-learning and efficiency in the mode of delivery (Kenya ICT survey, 2007).

The main objective of this study was to assess how the existing technological infrastructure comprising: Computing, Communication, Internet and Policy framework influences the ICT adoption rate in educational institutions in Kenya, through a descriptive survey of High schools in Thika district in Kiambu county in Kenya.

Research Methodology

This study adopted a descriptive survey design incorporating both qualitative and quantitative research approaches. The population of the study was the school management and the teachers involved in ICT implementation in High schools in Thika District. The sampling techniques including Stratified, simple random techniques were used in this study. Stratified techniques was used to group the target population (Thika High schools) into two main strata namely; public and private schools. Then from each category, a 30% sampling was computed and ascertained the number of schools sampled. The study targeted a total of 92 respondents, however due to study limitations; the study gathered a total of 86 responses which represents 93.5% response rate as shown in the Table 1.

Table 1: Sampling Frame

Institutions	Number of schools	Sample Percentage	Schools per category	Respondent per school	Sample size
Public schools	62	30%	19	3	57
Private schools	25	30%	7	5	35
TOTAL	**87**	**30%**	**26**	**-**	**92**

From each of the sampled schools, five and three respondents were sampled from private and public school, in private were more than in public schools to reduce disparities for comparison purposes. Primary data was collected using questionnaires that contained both open and closed ended questions. Data was analyzed using statistical package for social sciences (SPSS) using statistical tools; percentages, frequencies, means, standard deviations, ANOVA , chi-square as well as interpretational analysis used to identify constructs, themes and patterns that were used to describe and explain issues being studied (Gall, Borg, and Gall, 1996).

Results and Discussion

Criteria for Placing ICT Infrastructure in Schools

The respondent were asked to rate the criteria used when placing ICT infrastructure for educational activities in the High school in the target region. Through multiple response analysis, the study established that the main criteria followed were the school management support and electricity supply availability as accounted by 79.3% and 69.5% respectively. Availability of ICT literate teachers and adequate security accounted for 67.1% and 65.9% respectively as shown in Table 2. This shows that placement of the ICT infrastructure in the schools was manly dependent on the school management support and availability of electricity supply.

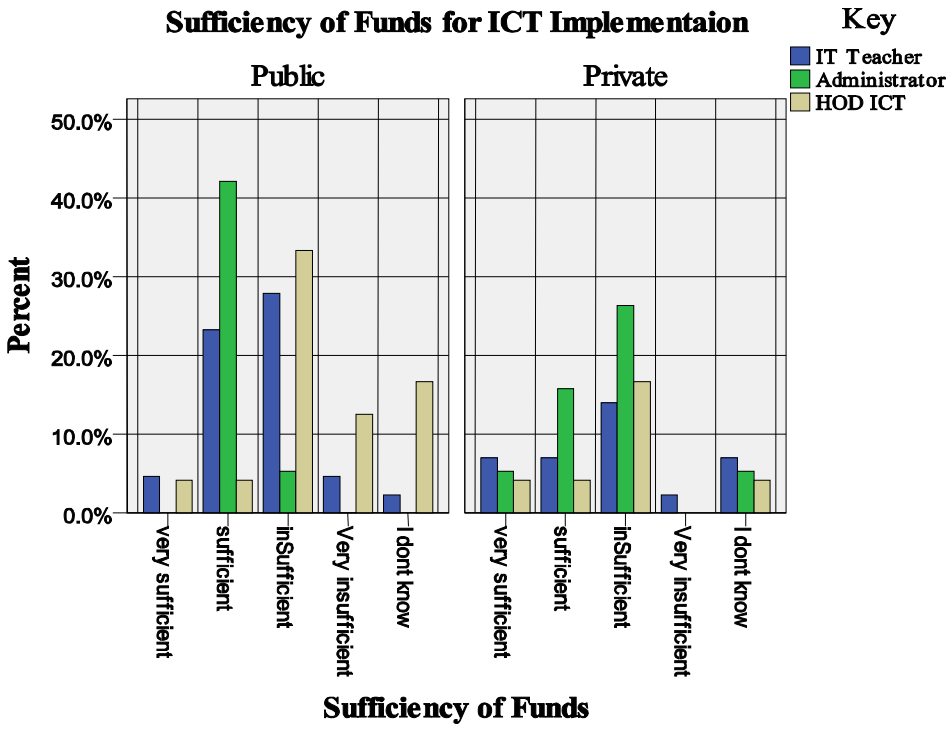
Table 2: Criteria for Placing ICT Infrastructure in Schools

	Frequency	Percentages %
School management support	65	79.3%
Electricity supply availability	57	69.5%
ICT literate teachers	55	67.1%
Adequate security	54	65.9%

Initial Cost of ICT Implementation

The findings show that in public schools 5% IT teachers and 5% heads of departments rated funds availability as very sufficient and 42% administrators; 23% IT teachers rated it as sufficient while 28% IT teachers and 33% heads of departments had different opinion of insufficient funds. They were further supported by 5% administrators, and 12% heads of departments who rated funds as very insufficient, with 17% heads of department being unable rate the availability of funds in public category.

On the other hand, 7% IT teachers, 5% administrators and 4% heads of departments rated funds availability as very sufficient in private secondary schools. Also 7% IT teachers, 17% administrators and 4% heads of departments gave sufficient response while 14% IT teachers, 27% administrators and 18% heads felt the funds were insufficient for ICT implementation in private secondary schools, with 7% IT Teachers, 5% administrators and 4% heads of departments unaware of funds availability in the school. This shows that less than half of the schools had sufficient funds to implement ICT to support education activities, while 41.5% public and 36.4% private responses indicated some degree of funds insufficiency as in Figure below.



This implies a good number of schools are experiencing funding gaps for ICT uptake as a cumulative public and private response show 24.6% of uncertainty.

Factor Analysis on Initial costs of ICT Implementation

To assess the key aspects that were significant in relation to cost of ICT Installation and Running, Factor analysis was conducted. An exploratory factor analysis (EFA) based on the principal component method with varimax rotation was conducted using SPSS package to detect the factor structure in the observed variables.

To examine whether the data set was appropriate for a factor analysis, the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy was utilized, where the result implied that the correlation matrix was not an identity matrix which justifies the use of factor analysis for the scale items.

Factor Variable Reduction

Only one component out of the 6 items was extracted with eigenvalues greater than 1.00, as summarized in Table 3. However, to determine the minimum loading necessary to include an item in its respective construct the criterion for factor loading inclusion has 0.5 and above with factor analysis utilizing principal component analysis. This six factor variables were combined to form a new component named "ICT Cost", whose mean and items are listed in Table 3, showing that there is high cost of funding ICT programmes in schools.

Table 3: ICT Cost Items

Items for ICT Cost; indicating that there is High cost of funding ICT programmes in schools with a factor mean of **2.56**
• High cost of ICT installation • High cost ICT maintenance • Lack of adequate ICT facilities and equipment • High cost of ICT support services • High cost of educational support soft-ware • Lack of funds to hire and sustain ICT personnel's

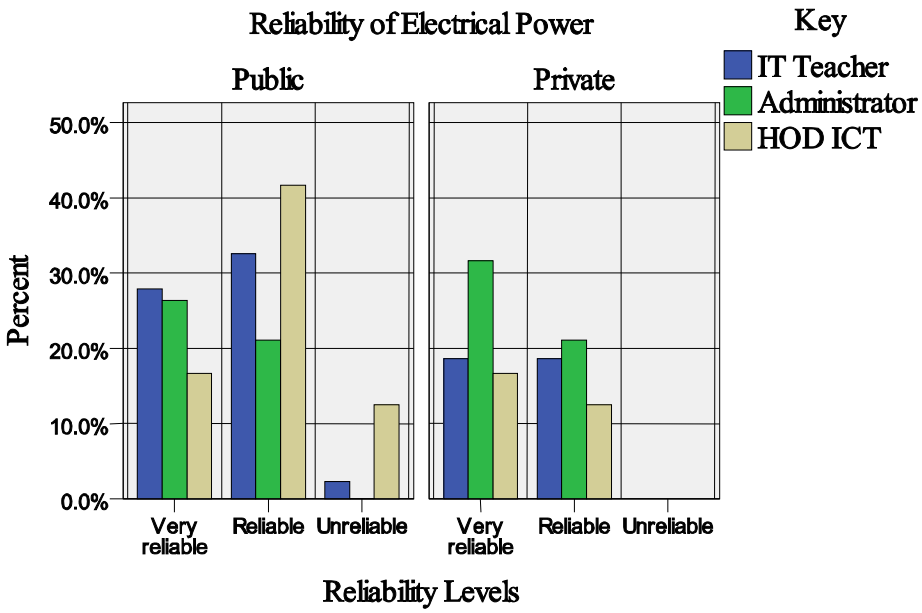
Key**:** 1.00 - 1.85 strongly agree, 1.86 – 2.65 agree, 2.66 – 3.45 neutral
3.46 – 4.25 disagree 4.26 – 5.00 strongly disagree

The study established, on average mean for ICT Cost as 2.56, implying that the views by most of the respondents agreed with the fact that high cost of funding ICT programmes was hindering its integration. This was supported by means of most of variables where respondent agreed that there is high cost of ICT installation, support services and requisite software implying that lack of adequate ICT facilities and equipment due to cost is an enormous barrier to ICT integration.

Reliability of Electrical Power Source

The findings show 29% of IT teachers, 28% administrators and 18% heads of departments(HoDs) in public schools rate electrical as very reliable, similar to 32% IT teachers, 20% administrators and 41% HoDs who rated electrical power as reliable. Only 2% IT teachers and 12% HoDs in public schools who rated electrical power as unreliable. In private schools, 19% IT teachers, 31% administrators and 17% HoDs rated electrical power as very reliable, with 19% IT teachers, 21% administrators and 12%HoDs giving reliable response.

This shows that the electrical power source for educational support in both school category was reliable as accounted by (reliable and very reliable) cumulative responses of 97.7% IT teachers, 100% administrators and 87.5% ICT heads as shown in the Figure below.



The trend on Electrical power reliability shows that on average there is reliable electricity connectivity in both public and private High schools. This shows that the electrical power source is not a challenge to the adoption and implementation of ICT in High schools. Which implies that there is a good foundation onto which ICT diffusion can be set in most of schools since power is a key prerequisite infrastructure for ICT adoption and implementation.

Internet Connectivity and Access

The findings show that most of the schools (both public and private) did not have any internet connection as accounted by 48.1% IT teachers, 55.6% administrators and 41.2% heads of departments in public schools as well as 25.0% IT teachers, 50% administrators and 57.1% heads of departments in private schools. However, majority of the respondents with the internet rated the speed of internet connectivity as low speed in both public and private schools as accounted by 18.5% IT teachers, 33.3% administrators and 23.5% departmental heads in public school as well as 37.5% IT teachers, 30% administrators and 14.3% departmental heads in private schools as shown in Table 4.

Table 4: Speed of internet connection

Respondent / Nature of school n = 86		Speed of internet connection					Total
		Very high speed	High speed	Low speed	Very low speed	No internet connection	
IT Teacher	Public	.0%	29.6%	18.5%	3.7%	48.1%	100.0%
	Private	12.5%	25.0%	37.5%	.0%	25.0%	100.0%
	Total	4.7%	27.9%	25.6%	2.3%	39.5%	100.0%
Administrator	Public	11.1%	.0%	33.3%		55.6%	100.0%
	Private	.0%	20.0%	30.0%		50.0%	100.0%
	Total	5.3%	10.5%	31.6%		52.6%	100.0%
HOD ICT	Public	5.9%	17.6%	23.5%	11.8%	41.2%	100.0%
	Private	.0%	28.6%	14.3%	.0%	57.1%	100.0%
	Total	4.2%	20.8%	20.8%	8.3%	45.8%	100.0%

The observable trend in both public and private High schools is that computers and other basic ICT equipment are prioritized and there after internet connectivity is acquired last probably due to costs or generation gap where old teachers oppose internet usage due to easier access of obscene materials by students. Thus there is inadequate internet access in schools which limit usage of computers and emerging technologies in leveraging teaching and learning activities.

However the few schools with access to internet experience challenges of connectivity speed as Only 29.6% IT teachers, 11.1% administrators and 17.6% departmental heads in public schools, with similar low ratings of 25.0% IT teachers, 20.0% administrators as well as 28.6% departmental heads in private schools who rated the connectivity as high. This shows that most schools have low speed internet connections hence hindering access, which limits use of internet enabled learning, content and communication, which slows the pace of ICT integration in High schools.

Factor Analysis on ICT Technological Infrastructure

To assess the key aspects that were significant in relation to ICT Technological Infrastructure, principal component Factor analysis with varimax rotation was conducted. Below is a presentation of factor variable reduction, ANOVA test, and the discussion of all the variables used in assessing the effects of existing ICT technological infrastructure.

Factor Variable Reduction

Two components out of the 6 items were extracted with eigenvalues greater than 1.00, and their KMO test was significant implying that the correlation matrix was not an identity matrix and rotation component matrix findings showed that the loading factors for the 3 variables namely; Poor state of ICT interconnectivity, low connectivity speed and low Internet access were rated as very important hence significant since their loading factors as the first component were greater than 0.5, hence they were combined to form one compound factor "connectivity" whose mean and items are listed in Table 5, and shows that there is inadequate connectivity in High schools resulting to slow pace of ICT adoption.

Table 5: Connectivity and policy Items

Connectivity Items that shows inadequacy of ICT infrastructure with a factor mean of **2.51**
• Poor state of ICT interconnectivity • Low connectivity speed • Low Internet access
Items for Policy that shows absence of a clear guidelines on ICT integration in High schools with factor mean of **2.27.**
• Lack of reliable educational support software • Absence of policy Guidelines regarding ICT • Lack of appropriate electronic educational contents

KEY: 1.00 – 1.85, - strongly agree, 2.66 – 3.45, - neutral, 3.46 – 4.25, - disagree,
1.86 – 2.65, - agree, 4.26 – 5.00, - strongly disagree

An overall mean of connectivity was established to be 2.51, which implies that on average respondent agreed that internet connectivity is a major challenge in schools though a key infrastructure component and that it inadequacy is a major drawback to the pace of ICT adoption.

On the other hand, the loading factors for; Lack of reliable educational support software, Absence of policy Guidelines regarding ICT and lack of appropriate electronic educational contents was found to be above the 0.5 threshold for second component, hence they were compounded to form one factor "policy', whose mean and items are listed in Table 5 above, showing that there is absence of a clear policy guidelines to schools on ICT integration.

This shows a significant agreement, that there is absence of policy guidelines in schools which is contributing immensely to the slow pace of ICT adoption. The overall mean for the policy component 2.27, imply that all the respondent were in agreement that policy issues regarding support software, and electronic educational content and it operationalisation is affecting the ICT diffusion negatively and delaying ICT usage as a tool for instruction. This means that; technological infrastructure involving both connectivity and policy is among the most important aspects of ICT that affect the pace of it adoption for educational purposes in education institutions in Kenya.

Satisfaction with the School's Policy on Computer Literacy for Students

The findings show that most of the respondents in both public and private schools were satisfied with the school's policy on computer literacy for students in support of educational activities as accounted by very satisfactory ratings of 11.1% IT teachers, 22.2% administrators and 17.6% departmental heads as well as satisfactory ratings of 48.1% IT teachers, 44.4% administrators and 41.2% departmental heads in public schools. While 18.8% IT teachers, 30%administrators and 42.9% heads of ICT departments in private schools rated policy as very satisfactory, with 43.8% IT teachers, 40% administrators rating it as satisfactory within the same school category as shown in Table 6.

Table 6: Satisfaction with the School's policy on computer use for students

Respondent / Nature of school		Satisfaction with the School's policy on computer use for students					
		Very satisfactory	Satisfactory	Un satisfactory	Very unsatisfactory	Not sure	Total
IT Teacher n= 43	Public	11.1%	48.1%	25.9%	3.7%	11.1%	100.0%
	Private	18.8%	43.8%	18.8%	.0%	18.8%	100.0%
Total		14.0%	46.5%	23.3%	2.3%	14.0%	100.0%
Administrator n =19	Public	22.2%	44.4%	22.2%	11.1%		100.0%
	Private	30.0%	40.0%	20.0%	10.0%		100.0%
Total		26.3%	42.1%	21.1%	10.5%		100.0%
HOD ICT n = 24	Public	17.6%	41.2%	17.6%	5.9%	17.6%	100.0%
	Private	42.9%	.0%	28.6%	.0%	28.6%	100.0%
Total		25.0%	29.2%	20.8%	4.2%	20.8%	100.0%

The Schools shows a trend of having a satisfactory Policy on Computer usage towards enhancing computer literacy for students learning activities in the schools. On average, half of schools both public and private have available ICT policy statements on student literacy course. The question is whether the policy is operational since other observable indicators point out a very low level of ICT usage and only one subject is taught via ICT aided devices in most of secondary schools. However, 30.0% on average across the groups view the policy as unsatisfactory or lopsided due to absence of integration inclusion of other disciplines, and a further 25% were not aware of any available policy guidelines. This shows that there is absence of a proper working ICT policy in schools and is a major drawback towards bridging the digital divide in secondary schools.

ICT Adoption in High Schools

The study established that the pace of ICT adoption variable is slow, as supported by 21% IT teachers, 10% administrators and 34% departmental heads in public schools who rated the pace as slow, while 19% IT teachers, 32% administrators and 21% heads of departments in public schools rated pace of ICT adoption as very slow. Additionally 14% IT teachers, 27% administrators and 12% heads of departments in private schools rated ICT adoption pace as slow, with 7% IT teachers, and 5% administrators giving a very slow response within private category as shown in Figure below.

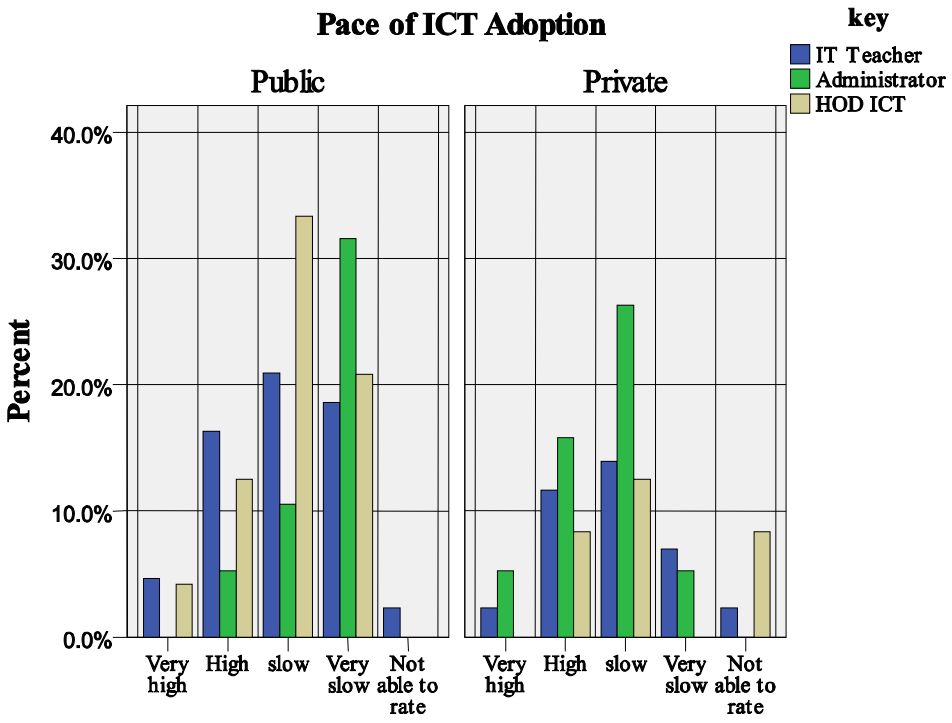


Figure 4.5: Pace of ICT Adoption for Educational Support

There is slow pace on ICT adoption trend in High schools as high and very high responses for all respondent groups were quite low with 4% IT teachers, 4% administrators in public schools accounting for very high pace and 26% IT teachers, 5% administrators as well 12% departmental heads in public view the pace as high. While 3% IT teachers and 6% administrators in private schools see the pace as very high, while 11% IT teachers, 16% administrators and 9% departmental heads within same category view it as just high adoption pace. This shows that the ICT integration rate is quite low in schools and is supported further by a low ratio for IT teachers to students of 1:300 with most of schools having one IT teacher at 55.6% and 62.5% in public and private schools respectively. computer to student ratio was low with most of schools having only one computer laboratory with twenty (20) computers, and offering only one subject via ICT driven practices. In terms of internet connectivity; 55.6% public and 57.1% private schools had no internet access implying that they had no e-mail access/use for educational purposes in schools. More over, 39.6% public and 39.4% private schools had neither ICT policy framework nor basic guidelines on ICT implementation, a condition that leave schools with too little awareness on ICT opportunities, requisite infrastructure, ICT potential and it operationalization mechanisms.

Conclusions and Recommendations

Conclusions

There is ambivalence in ICT infrastructure acquisition and usage in High schools in Kiambu county in Kenya. The paradox is that, in spite of Government goodwill and positive theoretical formulations that ICT forms the infrastructure backbone that would stimulate economic growth, efficiency in service delivery and development of rural community, there still exist scarce technological resources for learning and training of requisite human capital in High schools Kiambu county in Kenya. These have created secondary graduate of less technology nous, leading to problems rather than development as country experiences under employment, loss of workforce, insecurity and low capacity for effective production of goods and services.

The study concludes that there are very low levels of ICT adoption in secondary schools in Kenya, as low IT competency, inadequate ICT infrastructure, high cost of funding ICT programmes, complex perception of ICT usage, and absence of sufficient policy framework were established as the core barriers of harnessing ICTs in education sector. The statements below respond to research questions that guided this study.

- High cost of funding ICT programmes as start-up or running cost has lead to a considerable technological lag in secondary schools in Kenya.
- Inadequate psychological preparedness has dragged perception change which as hampered technology acceptance and usefulness in secondary schools.
- Low levels of information technology literacy in secondary schools as limited the usage of emerging technologies in leveraging teaching and learning.
- Inadequate connectivity and network infrastructure as hindered full access to internet resources, e-mail use and resource sharing in secondary schools in Kenya.

Recommendations

1. This study recommends to the ministry of education to improve the current ICT strategy for education to make it a three tier policy frame work to address specific needs of individual levels of institutions., with first tier being the policy for tertiary institutions, second for secondary schools and finally for primary schools. These levels in education sector have different needs, both in their core duties, infrastructure and human capacity requirement and thus need to have specific targets, mechanisms and timelines addressed separately for Education Sector to attain any tangible and observable ICT diffusion levels. Accordingly different institutions within levels may be at different stages of adoption hence the policy frame work should be whole inclusive to address needs of different adoption stages.

2. The study recommends the government to increase the ICT budget to address adoption challenges in secondary schools as the survey found that high cost of funding ICT programmes is immensely influencing ICT integration. Adequate ICT budget should be provided to empower the operations of ministry of information and communication as well as the ministry of education with a focus of bringing down the cost of ICT adoption.

3. The study recommends adoption of internet connectivity in the learning institution to empower resource sharing among them. Establishment of standard local area networks (LANs), wireless systems such as VSAT technologies and operationalization of EMIS should be prioritised. The government to reconsider her policy target of ensuring all secondary schools and tertiary institutions have affordable internet access by the year 2010 to make it a reality.

References

Athanasios Nikas (2003). *Network Information Infrastructures in the construction Industry:* Emergence and impact on work and management arrangements.Department of Management Science and Technology: Athens University of Economics and Business

Avgerou C. (2001). The significance of context in information systems and Organizational Change. *Information Systems Journal*. Volume 11, Issue 1, January 2001, Pages 43 – 63.

Blass E. and Davis A. (2003). Building on Solid Foundations: Establishing criteria for e-learning development. *Journal of Further and Higher Education*, 27 (3).

Cohen G., Salomon I. & Nijkamp P. (2002). Information Communications Technologies (ICT) and transport: does knowledge underpin policy? *Telecommunications Policy* Volume 26, Issues 1-2 , February-March 2002, Pages 31-52.

Davis J., Foxall G. and Pallister J. (2002). *Beyond the intention-behavior mythology*: An integrated model of recycling, Marketing Theory 2 (1), pp.29-113.

Duncan, N.B. (1995). *The Invisible Weapon: A Study of Information Technology Infrastructureas a Strategic Resource*. Dissertation, Texas A&M University.

Duncombe, Richard, and Heeks, Richard (1999), *Information, ICTs and Small Enterprise: Findings from Botswana,* Institute for Development Policy Management, University of Manchester, United Kingdom: Manchester

Earl, M.J. (1989). *Management Strategies for Information Technology*. United Kingdom: Prentice-Hall.

El-Shinnawy, M., and Vinze, A. S. (1997), Technology, culture and persuasiveness: A study of choice-shifts in group settings. *International Journal of Human-Computer Studies, 47*, 473-496.

Fishbein M. and Ajzen, I., 1989. *Understanding attitudes and predicting social behavior*. Englewood Cliffs, NJ: Prentice-Hall.

Foros Q., Kind H.J. & Sand J.Y. (2005). Do internet incumbents choose low Interconnection quality? *Information Economics and Policy*. Volume 17, Issue 2, March, Pages 149-164.

Global e-Schools and Communities Initiative (GeSCI) (2009). Kenya: ICT in Education Situational analysis; ministry of Education. Government printers.

Government of Kenya (2007), Kenya Vision 2030: A Globally Competitive and Prosperous Kenya, government of Kenya, Nairobi, Kenya

Government of Kenya (2006). National information and communication technology (ICT) strategy for education and training. Ministry of Education. Government printer

Government of Kenya (2005), National information and communications technology (ICT) Policy. Ministry of information and communications. Government printer

Government of Kenya (2004). *A policy framework for education, training and research.*

Meeting the challenges of education, training and research in Kenya in the 21st century. Ministry of education, science and technology. Government Printers.

Nelson, Samuel Mann and Noel Bridgeman (Eds) (NACCQ 2007), *20th Annual Conference of the National Advisory Committee on Computing Qualifications* New Zealand. www.naccq.ac.nz accessed on April 2013.

Laudon, K. C. and Laudon, J. P. (2001). *Essentials of Management Information Systems*.(Ed) New Jersey: Prentice Hall

McKay, D.T. and Brockway, D.W. (1989), "Building I/T infrastructure for the 1990s". *Stage by Stage*. Nolan Norton and Company, 9(3), 1-11.

Organization for Economic Co-operation and Development [OECD] (2004). *ICTs and Economic Growth in Developing Countries* Unclassified OECD report no. DCD / DAC/ POVNET (2004)6 /REV1

Rogers, E.M. (1995). *Diffusion of innovations.* 5th edition. The Free Press. New York.

SAITIS (2005), *South African ICT Sector Development Framework*. Available on the Internet: http:/ www.dti.gov.za/saitis/docs/ictnov-00-summ.html.Accessed 20April, 2013.

Van Akkeren J. and Cavaye, A.L., (1999). *Small business IT market readiness and overcoming their fear factor*. Proceedings of the 10th Australiasian Conference on Information Systems (ACIS99, p1071-1083). Wellington, New Zealand, Dec.

Van Akkeren J. and Harker, D., (2003). The mobile Internet and small business: An exploratory study of needs, use and adoption with full-adopters of technology. *Journal of Research and Practice in Information Technology*, 35(3), 205-220.