

The Extent of Implementation of Information and Communication Technologies in Kenya's Rural Secondary Schools; The Case of Igembe Schools

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Abstract: *Information and Communications Technologies (ICTs) in secondary schools entail the convergence of computers, telecommunication devices, Internet of things (IoT) and audio-visual systems. In this study, ICTs were used to mean the use of computer hardware, software, networking and the Internet, and other media of communication such as television, radio, newspapers and mobile phones. The objective of the study was to establish the factors which affect the implementation of the ICTs in secondary schools. A census study was conducted at the 38 schools out of 40 secondary schools in Igembe district. To collect data the researcher used a structured questionnaire that was personally administered to the respondents. Data was analysed using frequencies, averages, standard deviations, percentages, Friedman's test and Factor analysis techniques. The researcher found out that over 50% of the Igembe secondary schools had not yet acquired computers and none had the internet connection by the time of the study. The extent of implementation and ICT usage in Igembe district was limited to the traditional ICTs such as radios, television sets, newspapers and just a few and sparse computers and mobile phones which were mainly used for; mailing and chatting with peers, leisure and entertainment, office work, and students' information search.*

Keywords: ICTs, Extent, Implementation, theories

1. Introduction

Information and Communications Technologies (ICTs) entail the convergence of computers, telecommunication and audio-visual systems, that enable the collection, processing, transportation and delivery of information and communication services to users. The need for schools to invest in ICT in Kenya has been emphasized by the Kenya Government through the ministry of information. The Government of Kenya recognizes the role of ICTs in the social and economic development of the nation and has promulgated a national ICTs Policy based on the Economic Recovery Strategy for Wealth and Employment Creation (2003-2007) (<http://www.information.go.ke>). The rationale and implications of the ICT policies in schools can lead to different emphases in the way that ICTs are introduced and used in education, in particular at the secondary school level. ICT is used to refer to the use of computer hardware, software and networking, and other media of communication such as television, radio, and other modes of telecommunications such as mobile phone usage. In this study, the researcher will mainly focus on the use of computers and the Internet for learning. Internet proffers a conveniently accessible and easy-to-use global platform that supports a wide array of learning and knowledge dissemination activities (Allen & Seaman 2006). In any case digital convergence is bringing all the technologies together through the Internet (Omolo, 2003).

According to Reidlinger and Weir (1995), ICTs can support learning in a number of ways; it can facilitate communication, increase access to information, provide greater learning easiness to students with special education needs, and motivate students because of their enhanced problem solving capabilities and deeper understanding. Successful implementation of ICTs in secondary schools can be achieved through: engaging skilled teachers; employing supportive ICT infrastructure; having access to, and the

development and application of, online resources and services; instituting enabling policies and strategies that facilitate the uptake and usage of ICT within schools; facilitate Public - Private Partnerships to mobilize resources; promote the development of integrated e-learning curriculum to support ICT in education; promoting distance education and virtual institutions; facilitate sharing of e-learning resources between institutions; and integrating e-learning resources with other existing resources (Reidlinger and Weir, 1995). Successful implementation of ICTs in secondary schools can be achieved through: engaging skilled teachers; employing supportive ICT infrastructure; having access to, and the development and application of, online resources and services; instituting enabling policies and strategies that facilitate the uptake and usage of ICT within schools; facilitate Public Private Partnerships to mobilize resources; promote the development of integrated e-learning curriculum to support ICT in education; promoting distance education and virtual institutions; facilitate sharing of e-learning resources between institutions; and integrating e-learning resources with other existing resources (Reidlinger and Weir, 1995).

Implementation of ICTs in Schools; Tornatzky & Klien (1982) defines implementation as all the organizational activities working toward the management and routinisation of an innovation. Before implementation ICTs must be adopted, adoption involves the investment of funds into the idea, product or technology that facilitates the conduct of business electronically (Vasudevan, 2001). In schools ICT can be adopted in curriculum and materials development, which may entail using IT in the preparation of schemes of work, timetabling, lesson planning, learning manuals, teaching, and examination processes (Obura et al, 2003).

Overview of ICT Situation in Igembe District and in Schools; Igembe district is in Meru County in the old Eastern Province of Kenya. The district is located 54 kilometres

away from Meru town and to the east of Nairobi city. According to the Meru North Development Plan (2002), the development of the ICT sector has been lagging behind in Meru North District owing to ignorance, high illiteracy levels and lack of resources. According to Meru North Development Plan (2002), the government would facilitate the creation of the necessary infrastructure and provide resources in form of finances and equipment for the development of ICT sector, the ministry of finance and planning would establish the District Information and Documentation Centre (DIDC) while the ministry of transport, communication and information and that of tourism would provide the regulatory framework for the operation of ICT. The Kenya Broadcasting Corporation was the main radio and television broadcaster in this region. Some of the Nation dailies read locally were Daily Nation, East African Standard, the people and Kenya Times. The Internet access was negligible with only one Cybercafé in Maua Town at the start of the planning period (Meru North Development Plan, 2002).

Meru North Development Plan (2002) suggested three important factors that would help achieve the above plan as; (a) *physical infrastructure* which includes good telecommunication networks, state-of-the-art electronic machines and buildings; (b) *Public administration* that ensures safety, law and order, peace and stability; (c) *Human resources development* that would ensure people's education and innovativeness and keeping citizens healthy.

According to the Ministry of Education (2006), ICT department review data of 2006, 17 public secondary schools in Meru North District were connected to the electricity power grid through the Kenya Power and Lighting Company and had also acquired power generators as the standby power source. Education Ministry's ICT department also showed that 13 secondary schools had established computer labs. The studies done on ICT implementation in learning institutions did not address the extent of the implementation of ICTs in rural secondary schools, for instance, Ndungu (2005) restricted the focus of his study only on computers use in high schools ignoring other ICTs. Omolo (2003) concentrated on ICT implementation in secondary schools in Nairobi city, which is urban.

1.1 Statement of the problem; when ICTs are appropriately used in schools they ensue immeasurable benefits, they enable; universal accessibility of education and training, cheapness of education to wider population, empowerment of learners, quality of teaching and the speed in data processing and communication due to insurmountable network capabilities. Implementation of ICTs in schools in Kenya is ongoing, however, the level to which the implementation has been done is not known and thus there is need to know the extent to which ICTs have been implemented in schools so that the schools administration, the ministry of education, the sponsors like the parents and NGOs, the Government and the general public could be appropriately advised about the extra effort and resources required so as to achieve the set goals relating to the ICTs implementation. The objective of this study is to establish the extent of implementation of the ICTs in rural secondary schools in Igembe district. Studies which have been

previously undertaken relating to ICT implementation in schools left out implementation considerations in rural schools, for instance, Muganda's (2006) study was based in the University of Nairobi, ndungu's (2005) study was in Kenya High School in Nairobi, and Omolo's (2003) study was secondary schools in Nairobi. The three researchers suggested further studies to be carried out in rural schools, hence the need for this kind of study.

1.2 Importance of the study; the secondary school administration and the ministry of education may require the predictive information from this study to develop better strategies for successful and effective implementation of ICTs in the schools. The ICT students and researchers will be benefit from the findings of this study in their endeavours of carrying out further related researches, the suggestions from this study point out the gaps in knowledge that future studies can try to address. ICT consultants will be informed about the status of ICT implementation in the rural secondary schools and thus they will be able to offer informed guidance. The parents and the citizens or publics will be enlightened by the findings of the study, that is, they will be able to ascertain the progress being made in the schools and whether their children are getting the value for their money.

1.3 ICT application in Schools

Technology-assisted learning improves students' acquisition of knowledge and supports vocabulary learning (Hui et al 2008). Internet provides a conveniently accessible and easy-to-use global platform that supports a wide array of learning and knowledge dissemination activities (Allen & Seaman 2006). Zhang et al (2004) argues that instructors can deliver course materials through a designated Web site, from which students access those materials and interact with the instructor and their peers remotely. Masie (2002) recommends technology-assisted learning to only be complementary to face-to-face learning so as to support students' acquisition and accumulation of explicit knowledge rather than tacit knowledge and ensure improved feedback to learners (Rosenberg, 2001; Johnson et al., 2000; Abraham, 2002). Moreover, a course management system (CMS) supplements lectures, in that it is an alternative representation of lecture content in ways that may meet a wide range of students' needs (Morgan, 2003; Grabe and Christopherson, 2008), and IT is now supporting typing of examination rather than students handwriting the exam (Russell and Haney, 1997) and also virtual learning environment (VLE) which is a remote delivery of courses via the World Wide Web (Goodhue & Thompson, 1995; Chen & Dwyer, 2003).

2. Theoretical Literature

Gregor (2002) described theory as a system of rules, principles, a conjecture or an opinion. He also argued that it is an established proposition that is regarded and that reports matters of facts. Carbone (2009) describes theoretical framework as the structure of concepts which exist in literature, and that provide the structure and a guide for examining a problem and relationships between variables. The structure of this study will rely on more than one

interrelated theoretical frameworks, this is premised on the Mingers (2001) advocacy for a multi-theoretical and pluralistic approach in IS research when determining the theoretical and philosophical perspectives to apply. Diffusion of ICTs is the process by which an ICT innovation is propagated through certain channels over time among members of a social system, while adoption is a decision to fully use an innovation (Weigel et al., n.d, Rogers, 1983). An innovation is a new operational idea, practice, or an object as perceived by an adopter, who could be either an individual or even a group of individuals (Cooper and Zmud, 1990; Fichman, 1992)

2.1 The Sociological Perspective and Theories

Wang (2009) contended that social cognition produces an innovation concept and the popularity of that concept acts as the channel and driver of the IT innovations diffusion. He also concluded that for the practitioners and IT researchers to make sense of any new innovation and to be able to anticipate the impacts of that new ICT innovation they must first start by evaluating the innovation's fit with the broader business and social environment. Information systems research has drawn from social theories such as

i) Anthony Gidden's structuration theory (ST) helps the understanding of the information systems and their interaction with organizations, and how the nature of the interaction can result to strategic advantages to an organization or lack of it (Desanctis & Poole, 1994). AST examines the change process from two viewpoints: 1) the types of structures that are provided by the advanced technologies and, 2) the structures that actually emerge in human action as people interact with these technologies. Therefore, this theory can aid the researcher in describing the basic interactions of the ICTs and the secondary school structures to cause the envisaged favourable outcomes and/or change. 3) Medium Theory (MT) entails the study of the important characteristics of a medium. The nature of the medium determines the convenience of content transmission through that medium (McLuhan, 1994; Hansen, 2006). McLuhan stressed that due consideration should be made when selecting media to use in an organization, thus an organization should consider: a) message transmission speeds; b) Easiness to encode or decode messages in the medium, and; c) number of users using the medium and accessing the same message concurrently. Medium in this study will include the relevant ICTs including the Internet platforms that expand organizations' capacity and capability to perform its mandates (Kettinger & Grover, 1997; Fichman, 2000). Fichman postulated that saliency of a medium's characteristics is in its ability to be personalised, ability to deal with complex information needs, if they are economically viable and lastly, if they are able to provide a convenient communication configuration thus overcoming physical distance and time barriers (Kettinger & Grover, 1997).

ii) Organizing vision - it is a focal community idea for the application of IT in organizations (Swanson & Ramiller, 2004; Wang & Swanson, 2003). Organizing vision describes the usefulness and value of IT in a social way, therefore, companies rely on organizing visions to judge whether IT innovations have tactical or strategic contribution. According

to Wang & Swanson, organizing vision facilitates three aspects of IT innovation's diffusion; (a) interpretation of the existence of the innovation and purpose, this reduces the uncertainties associated with the new IT, (b) The vision legitimates the innovation by developing the underlying rationale for the innovation, (c) the vision helps mobilize entrepreneurial and market forces that emerge to support the material realisation of the innovation (Wang & Swanson, 2003). Organizing vision helps the community move beyond "one-size-fits-all" thinking, where it facilitates assembling of a certain trans-organizational know-how, enabling transmission and replication of the common competence among firms concerning an innovation (Swanson & Ramiller, 2004). Lastly, among all the social perspective theories structuration theory is the most influential and most commonly applied in information systems research (Desanctis & Poole, 1994), albeit difficulties to comprehend and employ. Majority of the social perspective theories used in IS/IT adoption research, the IT artefacts are either absent, black-boxed, abstracted from social life or reduced to surrogate measures and thus IT technical aspects taken for granted (Orlikowski & Iacono, 2001). Orlikowski & Iacono (2001) advocated the use of multiple theories in IT studies so as to incorporate the missing IT artefacts in most of the social theories.

2.2 Dominant Paradigms

2.2.1 Diffusion of Innovation Theory (DOI)

Diffusion is a process consisting of initiation, adoption and implementation (Rogers (1983). Initiation is generation of an innovative idea (Vasudevan, 2001), adoption is the decision to make full use of an innovation (Rogers, 1983), which involves investment of funds into the idea, product or technology (Vasudevan, 2001). While implementation involves the management and routinization of an innovation, up to system development and installation so as to achieving expected benefits (Tornatzky & Klien, 1982; Cooper and Zmud, 1990). The Diffusion of Innovations (DOI) theory is a theory of how, why, and at what rate new ideas, technology, and process innovation spread through an organization or a society over time (Rogers, 1995; Fichman & Kemerer, 1999), it also explains the variables that influence adoption of new information technology, such as the e-learning, Internet and cloud computing (Rogers, 1995). Kwon and Zmud (1987) alluded to six stages in the innovation process; initiation, adoption, adaptation, acceptance, routinization, and infusion (Rogers and Shoemaker, 1971; Rogers, 1995; Fichman & Kemerer, 1999; Weigel et al., n.d.). Organizational and technology adaptor characteristics may also determine adoption and diffusion of IT, these are; firm size and scope, technological competency, readiness and expected benefits, competitive environment's pressure and industry standards (Melville & Ramirez, 2008). Jeyaraj et al., (2006) added that other DOI's organizational characteristics that can affect the adoption of innovation may include; top management support, championship, organizational structure, centralization and formalization, internal influence and external influence, organizational size, and organization slack. Moreover, Green (2004) argued that managers play an important role in the diffusion process because they champion the adoption of new innovations by providing discursive justifications that rationalize and legitimize the new innovations' adoption.

2.2.2 Technology Acceptance Model (TAM)

TAM is the most influential and widely employed theory in information Systems (Lee et al. 2003) due to its high predictive power and its motivation of individuals to use information systems for individual benefits, for task-related purposes so as to improve the school's effectiveness, efficiency and also for quality decisions (Kettinger & Grover, 1997). Agarwal & Prasad (1997) presented six system success outcomes; system quality, information quality, user satisfaction, individual impacts, organizational impacts and system use or behaviour. Technology will be extensively adopted and used by schools if it will be viewed as an economical medium and where it is seen to support school activities in bringing out the anticipated results (Kettinger & Grover, 1997).

2.2.3 Technology-Organization-Environment (TOE)

Technology-Organization-Environment (TOE) Framework describes the process of technological innovation (Tornatzky & Fleischer, 1990; Lippert & Govindarajulu, 2006) and can help in the study of the adoption of technological innovations in schools (Zhang et al., 2007). TOE posits that technology context, organization context, and environment context influence adoption and implementation of relevant technologies in areas such as education (DePietro et al., 1990; Lippert & Govindarajulu, 2006; Zhang et al., 2007). *Technological context* encompasses the available technologies, equipment and processes that are important for the organization's productivity (DePietro et al., 1990; Lippert & Govindarajulu, 2006). *Organizational context* entails the characteristics and available resources of an organization that are capable of supporting adoption of innovations, this include the firm size, intra-firm communication processes or interconnectedness, centralization and formalization degrees, complexity of the managerial structures, quality and availability of the qualified teachers, slack resources' amounts, and linking structures between members of staff and students in a school (Lippert & Govindarajulu, 2006). Government influence is a significant environmental factor in government-sponsored

secondary schools (Zhang et al., 2007). ICTs are seen not as end in themselves but as means for improving students' outcomes across all curriculum areas and for driving organisational change. The hardware and technical infrastructure and the interconnection of schools via the Internet is a necessary expenditure that will guarantee online accessibility of learning resources and improved overall ICT strategy in schools (<http://www.edna.edu.au/preview/schools/reports/learningonline.pdf>). ICT implementation in schools will differ across schools, and mainly will depend on whether a school has adequate infrastructure or not (Omolo, 2003). Implementation will involve use of networks, internet access and usage, ICT planning, funding in schools, professional development of teachers and formal ICT policies in schools. Major constraint being lack of funds (Omolo, 2003), organizations to develop and implement sustainable ICTs will require a good implementation framework detailing the financial, technical and institutional support (Ndungu, 2005).

2.3 Empirical Literature

Some of the studies that have used DOI to explain adoption and implementation of ICTs are; Bradford & Florin (2003); Mustonen-Ollila & Lyytinen (2003); Cooper & Zmud (1990); Brancheau & Wetherbe (1990); and Greenhalgh et al. (2004). Some of the recent studies that have used TAM to explain ICT adoption and implementation are; Chan & Lu (2004); King & He (2006); and Bradley & Lee (2007). The studies that used TAM in learning environments are; Park (2009); Lau & Woods (2008); Hu, Clark, & Ma (2003). TOE as a model has been used to study factors affecting adoption and implementation of ICTs in organizations; Lee & Shim (2007); Zhang, Cui, Huang, and Zhang (2007); Henriksen (2006); and Pan & Jang (2008). Studies that used institutional theories are; Jeyaraj, Rottman, Lacity (2006); and Zhang, Cui, Huang, and Zhang (2007). Lastly there is one study that used organizing vision by Klecun-Dabrowska & Cornford (2002).

Table 1: Summary of empirical studies

Study	Purpose of the Study	Theories applied	Main Findings	Gap
Attewell, P., 1992	Technology diffusion and organizational learning	DOI Interviews	A theoretical framework for examining the diffusion of complex production technologies was developed	Knowledge barrier approach to technology diffusion as a distinct theory in its own right should be treated distinctly
Lau, S. & Woods, P. C. (2008)	An investigation of user perceptions and attitudes towards learning objects	TAM, TRA Web-based survey	The user beliefs and attitudes have significant positive relationships with behavioural intention, which in turn helps predicting the actual use of learning objects. TAM was validated as a useful model in predicting user's future behaviour	There is need for a longitudinal approach other than a snapshot study conducted and include other areas of study
Park, S. Y. (2009)	An analysis of the technology acceptance model in understanding university students' behavioural intention to use e-learning	Structural Equation Modeling (SEM), TAM, Questionnaire Survey	Confirmed TAM to be useful model in helping understanding and explaining behavioural intention to use e-learning. Both e-learning self-efficacy and subjective norm influence attitude towards e-learning and behavioural intention to use e-learning	carry out similar study on blended learning or synchronous e-learning
Seers, A. (2007)	Management education in the emerging knowledge economy: Going beyond those	Exploratory study	What holds and does not hold anymore in management education due to the transformation being caused by the emerging knowledge economy	To study into the precise forms of organizations as a result of the transformation in the knowledge economy

	“who can, do; those who can’t, teach”			
Chau, P. Y. K. & Hu, P. J. (2001)	Information Technology acceptance by individual professionals: A model comparison approach	TAM, TPB, (i.e. the decomposed TPB) models Questionnaire survey	Perceived usefulness and attitude were found to be the most significant factors for physicians’ acceptance of telemedicine technology, and PEU had no significant effect on PU and attitude. Compatibility is significant for predicts PU	Additional factors over the TAM and TPB factors to help counter constraints encountered in predicting technology acceptance by individual professionals
Gopalakrishna, S. & Bierly, P. (2001)	Analysing innovation adoption using a knowledge-based approach in commercial banking industry	Expert survey Survey Questionnaire	Provided partial support for development of an organizational innovation typology using knowledge-based approach	Study non-linear relationships between adoption parameters, and include organizational-related factors and their impacts on innovation adoption
Klecun-Dabrowska, E. & Cornford, T. (2002)	The Organising vision of Telehealth	Organising Vision Interviews	Found out that the organizing vision of Telehealth is compelling	Positive experience of telehealth initiatives may not be transferable between countries, regions, individual institutions or projects, thus requiring validating
Hu, Chau, Sheng & Tam (1999)	Examining the TAM using physician acceptance of telemedicine technology	TAM Questionnaire survey	The results suggested the general adequacy and applicability of TAM in the adoption of telemedicine technology	TAM limited power to explain attitude and intention, therefore need to go beyond the original TAM Study did not test a full TAM
Hu, P., J., Clark, T., H., K. & Ma, W., W. (2003)	Examining Technology acceptance by school teachers; a longitudinal study	TAM Laboratory session	Job relevance, technology usefulness, ease of use and user acceptance were the main determinants of the technology acceptance decisions by teachers in schools	Study to be carried out over longer time span and broader spectrum of respondents (teachers)
Jeyaraj, A., Rottman, J. W., Lacity, M. C. (2006)	A Review of the predictors, linkages, and biases in IT innovation adoption research	TAM, TAM2 DOI Social Cognitive Theory	Dominant paradigm for the adoption of ICT innovations by individuals and organizations continue to make significant progress.	Explore boundaries within and outside the dominant paradigm
Zhang, C., Cui, L., Huang, L., and Zhang, C. (2007)	Exploring the role of Government in information Technology diffusion: An empirical study of IT Usage in shanghai firms	TOE, Institutional Theory	In-depth examination of government impact on IT adoption in national, semi-national and private institutions. Results suggest environmental factors like government policies	Study to focus various industries and other economies such as other developing countries

3. Research Methodology

3.1 Research Design

The descriptive survey design was used for this study to establish and describe the extent that ICTs have been adopted and implemented in secondary schools in Igembe district. Survey research is appropriate for collecting data from members of a population and describing existing phenomena by asking individuals about their opinion, attitudes, behaviour or values, and then summarizing and reporting the way things are (Mugenda & Mugenda, 1999; 2003). It is often used to study the general condition of people and organizations as it investigates the behaviour and opinion of people usually through questioning them (Cooper and Schindler, 2003).

3.2 Target Population, Sampling Design and data collection technique

The target population for this study was all the 40 secondary schools in Igembe district. The respondents were the school principals or their representatives who could be either the computer studies teacher or any other teacher who is knowledgeable in ICT in the respective secondary schools,

therefore researcher’s own insight was required to judgmentally select appropriate respondents in this study. Mugenda & Mugenda (2003) defines sampling as the process of selecting a number of individuals for a study in such a way that the individuals selected are representative of the large group from which they are selected. According to Mugenda & Mugenda (2003) when target population is small a census or survey study is preferred to sampling, and since the population of interest was small a census study was done, all the elements in the population were involved where a principal or his/her representative filled a questionnaire in each and every school in Igembe district.

The researcher used a structured questionnaire for data collection. The questionnaires were personally administered to the respondents. This method was appropriate since it encouraged prompt responses from the respondents and helps addressing the specific objectives of the study (Mugenda & Mugenda, 2003). The questionnaire was structured into sections; Section I sought to capture the Demographic and Bio-Data about the secondary schools. This data enabled the researcher to get the schools’ outlook and gain a preview of the schools’ status in light of the ICTs so as to be able to categorize the school. Section II of the questionnaire sought data on the extent to which secondary

schools in Igembe district have adopted and implemented ICTs. This section was concerned with the ICT infrastructure, equipment and the level of their utilization.

3.3 Data Analysis

Quantitative data collected was analysed using Microsoft Excel and SPSS software that enabled data interpretation and making of statistical inferences. The collected data were coded, tabulated and then analysed using descriptive statistics, Friedman's test and factor analysis techniques. In particular, for data relating to section I the researcher used means, standard deviations and percentages to enable comparison of the different attributes being studied. Data captured in respect to section II were analysed using means, proportions, percentages, frequencies and also Friedman's test that was also to evaluate the relative importance of components.

4. Findings

4.1 Introduction

This chapter deals with data analysis and interpretation of the research findings. The chapter documents the factors that affect the implementation of ICTs in Igembe secondary schools. Out of the forty secondary schools targeted, only two schools were not reached to provide response. Therefore, the response rate was at 95%. The questionnaires were personally administered by the researcher. The chapter is divided into two sections. Section I concerns the respondents' demographic data, Section II concerns the extent to which secondary schools in Igembe district have adopted and implemented ICTs. The data in this study was summarized and presented in form of tables, frequencies, percentages, mean score, standard deviation and also rank ordering.

4.2 Demographic Factors

Demographic factors considered in the study included the age of the secondary schools, the schools administrative categorization, the number of students, the number of streams in the schools, the number of computer teachers and their qualifications, the number of computers, and whether the schools have explicit plans to acquire computers.

4.2.1 The Age of the Secondary School

Table 1: Age of Schools

Years	Frequency	Percentage
Not more than 5	20	52.6
06-10	1	2.6
11-15	4	10.5
16-20	5	13.2
21-25	2	5.3
Over 25	6	15.8
Total	38	100.0

Table 1 shows that 52.6% of the schools were five years old and below, 2.6% were between 6 and 10 years, 10.5% were between 11 and 15 years, 13.2% were between 16 and 20 years, 5.3% were between 21 and 25 years and 15.8% of the

schools were above 25 years of age. This connotes that over 50% of the schools are still in their formative stages and thus engulfed with the establishment of the physical infrastructure thus a big chunk of their financial resources are being channelled to buildings.

4.2.2 Number of Students and Computers

Table 2 (a): Classification of Schools using their Administrative categories

School Category	Number of students	Number of Computers	
	Mean	sum	Mean
District	199.03	61	10.17
Provincial	415.11	144	16.00

Table 2 (b): Classification of Schools using their Nature of Operation

School Category	Number of students	Number of computers	
	Mean	sum	Mean
Boarding	346.32	204	14.57
Day	154.11	1	1

Table 2 (c): Classification of Schools by their nature of ownership

School Category	Number of students	Number of computers	
	Mean	sum	Mean
Public	250.92	193	13.79
Private	237.50	12	12

Table 2 (d): Classification of Schools by gender

School Category	Number of students	Number of computers	
	Mean	sum	Mean
Girls	439.00	38	12.67
Boys	394.50	134	19.14
Mixed	183.19	33	6.60

Table 2 (a) depicts that provincial schools enrol more students than the district schools, Table 2 (b) indicates that boarding schools have a higher student enrolment than the day schools, Table 2 (c) indicates that public schools recorded a higher student number than the private schools, and Table 2 (d), in comparing the girls' schools, boys' schools and the mixed schools, the girls' schools recorded a higher number of students than the boys schools, while the mixed schools attracted very low number of students. Nevertheless, Table 2 (a) shows that the provincial schools have a higher number of computers than the district schools which have, Table 2 (b) indicates that boarding schools have more computers than day schools, Table 2 (c) indicates that public schools have a high number of computers compared to the private schools, and lastly, Table 2 (d), in comparing the Girls', Boys' and the mixed schools, Boys' schools had the highest number of computers, followed by the girls' schools and then the mixed schools had the least number of computers. There were 205 computers in total in all the secondary schools in the district. Given the enormous number of students in the district the computers are inadequate and thus there is need to plan to acquire more computers for use in schools.

4.2.3 Number of Streams for each Class

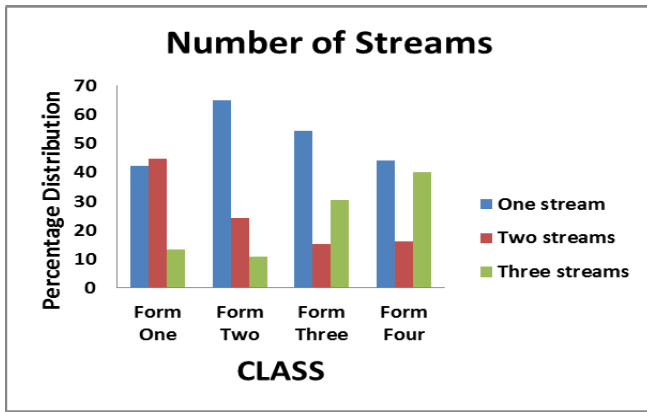


Figure 1: Number of Streams for each Class

Figure 1 indicates that the highest percentage of form ones in schools have two streams, followed by those that have one stream. The highest percentage of form twos in schools had one stream. Huge number of form threes in schools had one stream, and the fourth forms showed 44% of schools had one stream closely followed by schools with three streams.

4.2.4. Qualification of Computer teachers in secondary schools

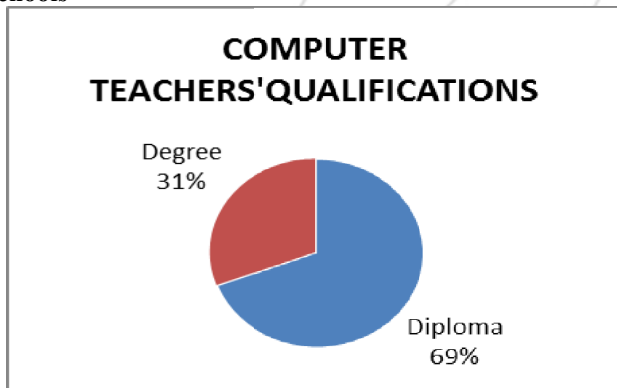


Figure 2: Qualification of Computer teachers in secondary schools

Figure 2 indicates that the computer teachers are qualified and competent. The teachers have a minimum of a diploma, 69% as compared to 31% who have degrees, however the number of teachers is insufficient.

4.2.5 Computers in Schools

Table 3: Number of Schools with computers

Number of computers	Frequency (schools)	Total number of Computers	Percentage
1	3	3	7.9
4	1	4	2.6
10	2	20	5.3
12	2	24	5.3
20	4	80	10.5
24	1	24	2.6
25	2	50	5.3
Total	15	205	39.5
Schools without computer	23		60.5
Total	38		100.0

Table 3 shows that 15 schools out of the 38 schools that participated in the study had acquired computers. 7.9% of the schools had only one computer in their schools, 2.6% had four computers, 5.3% had ten computers, 5.3% had twelve computers, 10.5% had acquired twenty computers, 2.6% had 24 computers and 5.3% had acquired twenty five computers. In total there are only 205 computers in the fifteen schools in the district, 39.5% of all schools have invested in computers, 60.5% of the schools in the district have not yet acquired any computer.

4.2.6 Adequacy of computers in Schools

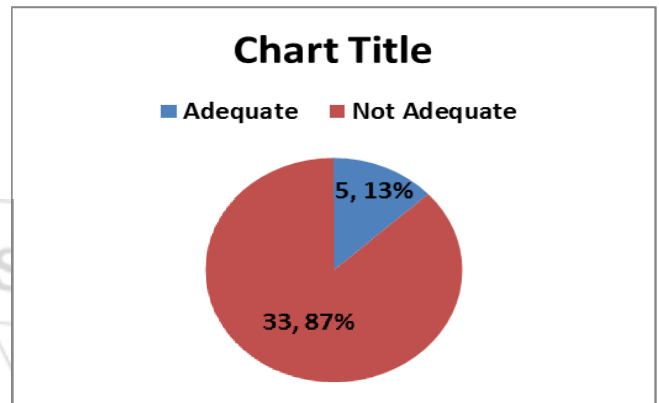


Figure 3: Adequacy of computers in Schools

Figure 3 shows that only a small percentage, about 13 % of secondary schools are satisfied with the level of computers available in their schools and the other 87 % argued that computers are either not there or are inadequate.

Table 4: Schools planning to buy computers for teaching

Schools	Frequency	Percentage
Planning	26	68.4
Not planning	12	31.6
Total	38	100.0

Table 4 shows that despite the fact that very many schools are not satisfied with the number of computers in their schools, 31.6% of the schools did not have any plan to acquire computers, while 68.4% of schools in the district are planning to acquire computers.

4.3 The Extent of ICTs implementation

To establish the extent to which ICTs have been implemented in Igembe Secondary schools, specific questions were posed to the respondents. The extent of implementation was inferred from the kinds of ICTs available in the schools and the applications that the various ICTs are being put into.

4.3.1 Number of Schools offering computer courses

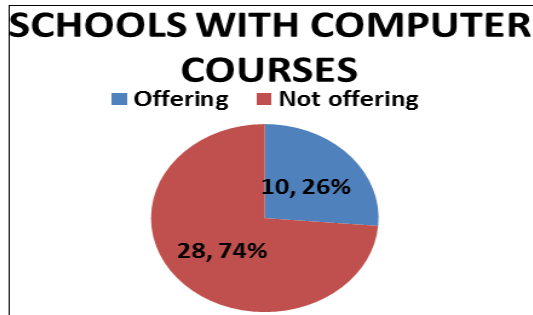


Figure 4 Schools offering computer courses

Figure 4 indicates that only 26% of schools out of the thirty eight that participated in this study had introduced computer courses in their schools, the other 74% of the schools had not.

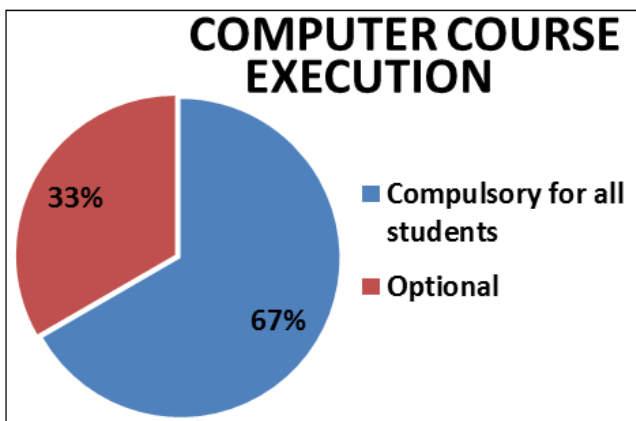


Figure 5: How the computer course is executed

Figure 5 indicates that out of the ten schools that had introduced computer courses in their schools 9 have responded to this portion of the questionnaire, 67% of the schools stating that the course was compulsory for all the students while 33% of the schools said that the course was optional. Generally, in Igembe district the computer course is compulsory for only the form ones and twos and thus made optional for the form threes and form fours who intend to sit for Kenya Certificate of Secondary Education (KCSE) examination in the computer course.

4.3.2. Internet connectivity

Internet connection is lacking in schools in Igembe District.

Table 5: Reasons for lack of Internet connectivity in the schools

Reason	Mean	Std.Deviation	Factors
Cost of connection	4.03	1.2625	1
Adequate Computers	3.63	1.7618	2
Technical Support	3.32	1.3970	3
Electricity	3.00	1.9728	4
Telecom Lines	3.16	1.6362	5
Clear ICT policy	3.11	1.5385	6
ICT Software Vendors	2.87	1.4918	7
ICT Equipment Vendors	2.82	1.4114	8
Internet know-how	2.95	1.6266	9

Table 5 is based on Friedman rank test, the test assigns weight based on the degree of importance of factors, it evinces the most important factors that lead to the lack of internet connection in secondary schools. The table therefore indicates factors 1 to 4 are the most important and thus

crucial in determining the availability of Internet connectivity, factors 5 and 6 as the averagely important and lastly, factors 7 to 9 as the least important.

4.3.3 ICT Media other than computers and Internet

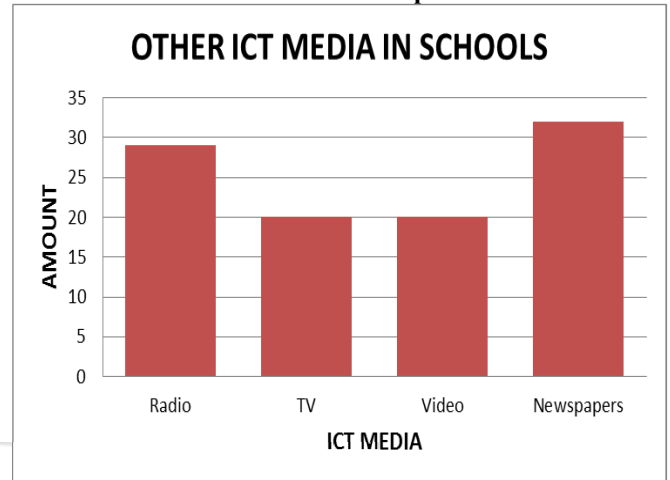


Figure 6: Other ICT Media being used in schools

Other ICT Media may include mobile phones, scanners, home theatres, printers, type writers and duplicating machine. Figure 6 shows that the newspapers have highest level of usage with 31.7%, radios follow with 28.7%, and the least used media are television sets and videos that have 19.8% of usage, each.

4.3.4 The extent of ICTs implementation in Secondary Schools

Table 6: The Extent of ICTs Implementation

ICT Application	Mean	Std. Deviation	Use
Mailing and chatting with Peers & friends	2.89	1.3313	1
Leisure and/or Entertainment	2.84	1.2846	2
Office Work	2.50	1.0843	3
Students' Information Search	1.97	0.7880	4
Staff Records and Pay Roll management	1.74	1.1551	5
Teachers Research and study	1.53	0.9792	6
E-Learning (For Teaching)	1.37	0.7136	7
Website to market the school to the Public	1.29	0.8353	8
Administration of On-Line Examinations	1.13	0.4748	9

Table 6 is based on Friedman rank test which assigned weights based on the degree of importance of the factors, to show the levels of usage or applications of the ICT media available in secondary schools. The table ranked applications 1 to 4 as the most common and thus important, application 5 to 7 as the averagely important, while applications 8 and 9 were not achievable by schools because they could not be appropriately supported by the ICTs available. The researcher found out that ICTs implementation in Igembe secondary schools is still at a very low extent with low level ICT infrastructure and applications.

5. Conclusions and Recommendations

5.1 Introduction

The objective of this study was to establishing the extent of ICTs' Implementation in secondary schools. This chapter presents the summary, discussions and conclusions from the research findings as per the objective of the study. Based on the findings, recommendations have been given on the extent of ICTs' Implementation in secondary schools. The limitations of the study as well as suggestions for further research have also been discussed.

5.2 Summary, Discussions and Conclusions

The demographics of the schools revealed that over half of the schools in Igembe district were less than five years old. This phenomenon explains the technological instability and backwardness in secondary schools in Igembe district. Provincial schools have higher enrolment of students as compared to the district schools and they also have more computers. Boarding schools have a higher enrolment than the day schools and thus they could afford more computers. Private schools did not have any computers as opposed to public schools which had a high number of computers. The boys' schools recorded higher numbers of computers than the girls' schools. Computer teachers are adequately competent with the most teachers having a minimum of a diploma qualification, and a few degree holders. Very negligible percentage of secondary schools was satisfied with the level of computers available in their schools, hence some schools exhibited an explicit plan to acquire ICTs in the near future.

The study revealed that there are 205 computers in only fifteen schools in Igembe district, with over half of the schools not having any computer. Most of the schools in Igembe district had made computer studies compulsory especially at form one and two, and it was optional for upper classes. The study showed that there were no schools with internet connectivity because the cost of connection was high, and that computers, technical support, and electricity connection were lacking in most of the schools. Other than the computers, the other ICT media being used in schools were cell phones, scanners, printers, type writers, home theatres and duplicating machines. The study revealed that ICT media were applied majorly in mailing and chatting with peers, leisure and entertainment, office work, and students' information search. In conclusion, the extent of implementation of the ICTs in secondary schools in Igembe district is quite low, most of the ICTs being used in the district are the traditional communication media such as televisions, radios, and newspapers. Over 50% of the secondary schools in Igembe district had not yet acquired computers. Moreover, none of the schools in the district had internet connection

5.3 Recommendations

This study has revealed the extent of the ICTs implementation and the factors that affect ICTs implementation in Igembe district secondary schools. The extent of ICT usage in Igembe district was limited to the traditional ICTs such as radios, television sets, newspapers

and just a few computers. The researcher recommends that the schools invest in computers, networking those computers and obtain Internet connection so as to enable the schools benefit from the on-line facilities and resources. The researcher recommends that the government and NGOs should develop an affirmative action geared towards automation and revolutionizing education systems by providing finances and other resources such as expertise to the schools.

5.4 Limitations of the Study

Considerable amount of time was spent administering the questionnaires, because the concept being tested had to be explained fully to most of the respondents, moreover, a majority of the school principals were ignorant and naïve about the concepts being tested and thus insisted on remaining with the questionnaire forcing the researcher to make several trips to the schools, making the study very costly in terms of time, effort and money. Most of the secondary schools were remotely and sparsely located and thus required that the researcher travel for long distances, some of the places did not have reliable means of transport hence had to walk through hilly and rocky roads to the schools.

5.5 Suggested Further Research

This study was conducted on rural secondary schools in Igembe district. As the study showed over 50% of the schools in the district were still in their initial development stages, huge chunks of their resources going to structural improvements such as buildings and basic teaching materials. However, given some more few years these schools will have stabilized and will then be able to invest in technologies such as computers and internet, hence there is need for subsequent longitudinal researches to study the trends in ICTs implementation in secondary schools in the district. Furthermore, ICT field is dynamic and therefore a research on the same area could be repeated after a period of say 5 years from now to benchmark the results. The study was restricted to only one district and thus the population was relatively small, hence more studies on ICT implementation in rural secondary schools can be repeated in other districts to validate the results of this study and enable proper generalization of the findings.

References

- [1] Abraham, T. (2002). Evaluating the virtual management information systems (MIS) classroom. *Journal of Information Systems Education* 13, 125–133.
- [2] Allen, I. E. & Seaman, J. (2006). Making The Grade: Online Education in the United States. Needman, MA: Babson Survey Research Group.
- [3] Attewell, P. (1992). Technology diffusion and organizational learning: The case of business computing. *Organizational Science*, 3(1), pp. 1-19
- [4] Bradford, M., & Florin, J. (2003). Examining the role of innovation diffusion factors on the implementation success of enterprise resource planning systems. *International Journal of Accounting Information Systems*, 4(3), 205–225.

- [5] Bradley, J., & Lee, C. C. (2007). ERP Training and User Satisfaction: A Case Study. *International Journal of Enterprise Information Systems*, 3(4), 33–50.
- [6] Brancheau, J. C., & Wetherbe, J. C. (1990, June 1). The Adoption of Spreadsheet Software: Testing Innovation Diffusion Theory in the Context of End-User Computing. research-article.
- [7] Chan, S., & Lu, M. (2004). Understanding Internet Banking Adoption and Use Behavior: A Hong Kong Perspective. *Journal of Global Information Management*, 12(3), 21–43.
- [8] Chau, P. Y. K. & Hu, P. J. (2001). Information Technology acceptance by individual professionals: A model comparison approach. *Decision Science*, 32(4), pp. 699-719
- [9] Chen, W. F. & Dwyer, F. (2003). Hypermedia research: present and future. *International Journal of Instructional Media* 30, 143–148.
- [10] Cooper, D.R and Schindler, P.S (2003). Business Research Methods: 8th edition, MC. Graw-Hill Publishing Ltd, New York.
- [11] Cooper, R. B., and Zmud, R. W. (1990). Information Technology implementation Research: A Technological Diffusion Approach. *Management Science*, 36(2), pp.123-139.
- [12] Gopalakrishnan, S. & Bierly, P. (2001). Analysing innovation adoption using a knowledge-based approach. *Journal of Engineering and Technology Management*, 18, pp. 107-130
- [13] Greenhalgh, T., Robert, G., Macfarlane, F., Bate, P., & Kyriakidou, O. (2004). Diffusion of Innovations in Service Organizations: Systematic Review and Recommendations. *Milbank Quarterly*, 82(4), 581–629.
- [14] Henriksen, H. Z. (2006). Motivators for IOS Adoption in Denmark: *Journal of Electronic Commerce in Organizations*, 4(2), 25–39.
- [15] Hu, J. P., Chau, P. Y. K., Sheng, O. R. L. & Tam, K. Y. (1999). Examining the Technology Acceptance Model using physician acceptance of telemedicine technology. *Journal of Management Information Systems*, 16(2), pp. 91-112
- [16] Hu, P., J., Clark, T., H., K. & Ma, W., W. (2003). Examining Technology acceptance by school teachers; a longitudinal study. *Information & Management*, 41, pp. 227-241
- [17] Hui, et al. (2008). Technology-Assisted Learning: A Longitudinal Field Study of Knowledge Category, Learning Effectiveness and Satisfaction in Language Learning. *Journal of Computer Assisted Learning* 24(3) , 245-259.
- [18] Jeyaraj, A., Rottman, J. W., Lacity, M. C. (2006). A Review of the predictors, linkages, and biases in IT innovation adoption research, *Journal of Information Technology*, 21, pp. 1-23
- [19] Johnson, S. D., Aragon, S. R. & Shaik, N. (2000). Comparative analysis of learner satisfaction and learning outcomes in online and face-to-face learning environment. *Journal of Interactive Learning Research* 11, 29–49.
- [20] King, W. R., & He, J. (2006). A meta-analysis of the technology acceptance model. *Information & Management*, 43(6), 740–755.
- [21] Lau, S. & Woods, P. C. (2008). An investigation of user perceptions and attitudes towards learning objects. *British Journal of Education Technology*, 39(4), pp. 685-699
- [22] Lee, C., P., & Shim, J. P. (2007). An exploratory study of radio frequency identification (RFID) adoption in the healthcare industry. *European Journal of Information Systems*, 16(6), 712–724.
- [23] Lippert, S. K. & Govindarajulu, C. (2006). Technological, Organizational, and Environmental antecedents to web services adoption. *Communications of the IIMA*, 6(1), pp. 147-160. Available at: <http://scholarworks.lib.csusb.edu/ciima/vol6/iss1/14>
- [24] Masie, E. (2002). *Blended learning: 'The magic is in the mix'*. In *The ASTD E-Learning Handbook: Best Practices, Strategies and Case Studies for an Emerging Field*. McGraw-Hill, New York
- [25] Ministry of Education of Kenya (2006). ICT Department Review.
- [26] Ministry of Information & Communications. “National Information & Communications Technology (ICT) Policy”, (2006): Retrieved 5/3/2008 from <http://www.information.go.ke>
- [27] Morgan, G. (2003). Faculty Use of Course Management Systems in the University of Wisconsin System. Educause Center For Applied Research Report. Available at: <http://www.educause.edu/LibraryDetailPage/666?ID=ERS0302> (accessed 12 June 2008).
- [28] Mugenda O.M. and Mugenda A. G. (1999). *Research Methods: Quantitative and Qualitative Approaches*, Acts Press, Nairobi.
- [29] Mugenda O.M. and Mugenda A. G. (2003). *Research Methods: Quantitative and Qualitative Approaches*, Acts Press, Nairobi.
- [30] Mustonen-Ollila, E., & Lyytinen, K. (2003). Why organizations adopt information system process innovations: a longitudinal study using Diffusion of Innovation theory. *Information Systems Journal*, 13(3), 275–297.
- [31] Ndungu, P.M. (2005). A framework for Implementation of IT in Kenya High Schools Focusing on sustainability. Unpublished M.Sc. Project, University of Nairobi.
- [32] Obura, et al. (2003). The Winning Formula of Computers for Schools Kenya. *International Development Research Centre* , pp.16-26.
- [33] Omolo, G. (2003). Factors Affecting Information and Communication Technology Implementation in Secondary Schools in Nairobi: Unpublished MBA Project, University of Nairobi.
- [34] Pan, M., J., & Jang, W., Y. (2008). Determinants of the Adoption of Enterprise Resource Planning Within the Technology-Organization-Environment Framework: Taiwan's Communications Industry. *Journal of Computer Information Systems*, 48(3).
- [35] Park, S. Y. (2009). An analysis of the technology acceptance model in understanding university students' behavioural intention to use e-learning. *Educational Technology & Society*, 12 (3), pp. 150–162.
- [36] Reidlinger, D. and Weir, H. (1995). “The Information Highway and Canadian Education: Discussion of Issues Policy Recommendation”, Paper prepared on

behalf of Canadian Education Net Coalition, the schoolnet National Advisory Board and Senator Alliance (Ottawa: Canada).

- [37] Rogers, E. M. (1983). *Diffusion of Innovations*. 3rd edition. The free Press, New York.
- [38] Rogers, E. M. and ShoeMaker, F.F. (1971). *Communication of Innovations: A Cross-Cultural Approach*. The Free Press, New York.
- [39] Rosenberg, M. J. (2001). *E-Learning: Strategies for Delivering Knowledge in the Digital Age*. McGraw-Hill, New York.
- [40] Seers, A. (2007). Management education in the emerging knowledge economy: Going beyond those “who can, do; those who can’t teach”. *Academy of Management Learning & Education*, 6(4), pp. 558-567
- [41] Tornatzky, L., and Klein, K. (1982). Innovation Characteristics and Innovation Adoption-Implementation: A meta Analysis of Findings, *IEEE Transactions on Engineering Management* 29 (1), pp 28-45.
- [42] Vasudevan, V. (2001). AWeb Services Premier. URL: [Http://www.xml.com/pub/a/2001/04/04/webserver/index.html](http://www.xml.com/pub/a/2001/04/04/webserver/index.html)
- [43] Zhang, C., Cui, L., Huang, L., and Zhang, C. (2007). Exploring the role of Government in information Technology diffusion: An empirical study of IT Usage in shanghai firms. In McMaster, T., Wastell, D., Ferneley, E., & DeGross, J. *Organizational Dynamics of Technology-Based Innovation: Diversifying the Research Agenda* (eds). *International Federation for Information Processing (IFIP)*, 235, pp. 393-408, Boston, Springer.
- [44] Zhang, et al. (2004). Can e-learning replace classroom learning? *Communications of the ACM* 47, 75–79.

