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Developing an Information and Communication Technology Infrastructure Management Archetype for Effective Integration of ICT in Secondary Schools in Kakamega, Kenya

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Abstract:
The purpose of the study was to develop an ICT infrastructure management archetype for ICT integration in public secondary schools. The study was guided by one main research question whose objective was to establish if there were significant differences between the status of management framework for ICT integration of public secondary schools which successfully integrated ICT and those which did not succeed in terms of ICT infrastructure, Implementation of school ICT policy, School leadership and Teachers' ICT competence. The study was predicated on Appropriate Technology Theory advanced by Reijs would in 2005. A concurrent mixed methods design was used in the study which had a sample of 22 public secondary schools in Kakamega County and 356 respondents drawn from the senior management teams in the schools. A questionnaire was used to collect data, an interview carried out among the ICT champions and a sub county director of education. Observation and documentary analysis were used to triangulate the responses from the questionnaire and interviews. Study findings indicated that there was a significant difference between schools that integrated ICT as compared to those that did not in terms of ICT infrastructure, Implementation of school ICT policy, School leadership and Teachers' ICT competence. The study recommends that school leadership should formulate ICT policy to guide the implementation process of ICT integration. School leaders should provide ICT leadership in the school.

Keywords: *ICT, infrastructure, management archetype, effective integration*

1. Introduction

There is no universally accepted definition of Information and Communication Technology (ICTs) because concepts, methods and applications related to ICTs are constantly evolving and can be contextually interpreted and applied. A broad definition of ICT is concerned with the distinction between 'old or traditional technologies (radio, television, video, DVD, telephones and computers) and new or modern technologies (video conferencing, e-mail, cellular telephones, weblogs, web 2.0 and other social networking software (Prof. Vassilios Makrakis, 2012). Nonetheless ICT integration in teaching and learning can be referred to as the seamless incorporation of technology to support and enhance student engagement in meaningful learning and for attainment of curriculum objectives. (MoEST, 2010).

Why introduce ICT into education? The rapid rate at which ICTs have evolved since the mid-20th century, the convergence and pervasiveness of ICTs give them a strong role in development and globalization (Nwagu, 2006). ICTs have a significant impact on all areas of human activity, (Brakel and Chisenga, 2003). It is imperative therefore that key stakeholders in education must be actively involved in ICT use and content and above all the pedagogical integration of ICT into education. Every stakeholder must be concerned about ICT in education because it is clear that ICT will continue to significantly impact all societies worldwide in economic, social and cultural aspects. Education cannot escape this trend. All over the world, different countries have consistently initiated programs that are directed in making teachers adopt and use ICT in their day-today teaching and learning practices in school. According to Jimoyiannis and Komis (2007) countries like UK, Singapore, China, Australia and European Union (EU) have established programs that aim at enhancing teachers' skills important in adapting and using ICT during teaching and learning processes.

Kenya as a country has worked towards developing capacities and competences in order to participate at the global level like other countries in the world. Thus the country has continually developed its human capacities and technological infrastructure. The Government of Kenya has prioritized Information Communication Technologies through four policy documents namely; The Sessional Paper1 of 2005, The National ICT Policy of 2006, the ICT Strategy for Education and Training of 2006 and The Kenya Vision 2030.

The single largest initiative of the government of Kenya to equip schools with ICT infrastructure was in the financial year 2009-2010 when the Economic Stimulus Programme (ESP) – ICT project was implemented in public secondary schools across the country. Under this particular programme, five public secondary schools in each of the country's 210 constituencies were identified and received funding of $ 9,800. per school. The funds were to be utilized in the procurement of ICT infrastructure as well as for training of teachers in the schools in the use of ICT.

These schools were to integrate ICT into the curriculum as well as become Centres of Excellence in ICT so that they could serve other neighbouring learning institutions in matters ICT. Kakamega County, at that time, had 9 constituencies and thus a total of 45 schools (5 from each constituency) were identified for ICT funding which translated to a funding of $ 392,000 for the County. However, from the Quality Assurance and Standards Assessment reports held in the CDE's office (Kakamega County) revealed that although the schools that had been funded for ICT and had procured the required infrastructure as per the guidelines provided, only four schools had endeavoured to integrate ICT into the curriculum. The situation is the same in the neighbouring counties of Bungoma, Vihiga and Busia. Most schools have not achieved the objectives of integrating ICT into the curriculum and becoming Centres of Excellence in ICT as envisaged, instead most schools have introduced computer studies as a curriculum subject.

While numerous studies (e.g. Manduku, Kosgei & Sang, 2010; Gakuu, & Kidombo, 2010; Peeraer, & Petergem, 2011; Laaria, 2013) have been carried out to determine the level of ICT integration and barriers of ICT integration, there has been no study in this country on the gaps in the management process of ICT integration in secondary schools. The researcher in this current study endeavored to establish if there were any gaps in ICT infrastructure management that could have been acting as an impediment to the successful integration of ICT into the curriculum.

1.1. Research Question

1. Is there a significant difference between the status of management framework for ICT integration of public secondary schools which successfully integrated ICT and those which did not succeed in terms of:
   a) ICT infrastructure
   b) Implementation of school ICT policy
   c) School leadership on ICT
   d) Teachers' ICT competence

1.2. Hypothesis

The study was guided by the following one main hypothesis:

Ho: There is no significant difference between the status of management framework for ICT integration of public secondary schools which successfully integrated ICT and those which did not succeed in terms of:

a) ICT infrastructure
b) Implementation of school ICT policy
c) School leadership on ICT
d) Teachers' ICT competence

2. Theoretical Framework

The study is predicated on the theory of Appropriate ICT developed by Reijswoud (2005), which is a modification of the Appropriate Technology developed by Darrow and Saxenian (1986).Although the criteria proposed by Darrow and Saxenian (1986) will result in an appropriate design of the technology, they fail to highlight the implementation process thus giving the Reijswoud theory an upper edge.

Reijswoud (2005) developed a framework that is founded on the traditional Systems Development Life Cycle (SDLC) that is used in Information Systems development, but extends it with tools and approaches that will guide the ICT solution to appropriateness. This framework for Appropriate ICT was to guide designers, implementers and maintainers of ICT to design and implement effective and sustainable solutions that address the needs, expectations and limitations of the targeted communities and allows the 'ordinary man' in Least Developed Countries (LDCs) to get connected to the information and knowledge society. According to Brandon (2006), SDLC comes in many types and flavors; However Reijswoud (2005) adopts a basic five-phase model entailing:

1) Definition: Determine the goals, scope and requirements of the ICT solution
2) Design: Resolution of technical issues, selection of architecture and standards
3) Construction: Implementation of the design, testing and documentation of the system.
4) Installation: Roll-out of the services offered by the systems to the end-users, training.
5) Operation/maintenance: problem solving, user support, and incremental improvement through monitoring an evaluation focusing on the use of the services by the end-users.

Appropriate ICT encompasses two perspectives: the product and process. According to Reisjwoud (2005), the product perspective is concerned with the design of the ICT systems that will be used to offer information and communication services. This covers all aspects from computers (and other connected electronic equipment), servers, network and connections. For example in this approach, a computer setup that is to operate in a community in the African desert is not considered to be appropriate when it is not well protected against heat, sand and dust. The product perspective is very much in line with the guidelines that were developed by Darrow and Saxenian (1986).

The process perspective is just as vital but has not received adequate attention up to this point. A mere techno-centric approach, even when rooted in the principle of Appropriate Technology (AT), will not deliver effective community-embedded ICT that will be appreciated and used by the potential end-users. In the framework this is expressed in three aspects: Hardware, Software and Change Management. Hardware and software result in a product, an ICT artifact. Change management establishes the process for the design, development and implementation of the ICT artifact. This article starts from the premise that Many ICT projects in LDCs fail to properly take into account the local context in LDCs. Failure may be caused by selection of inappropriate hardware, software and/or design and implementation approaches. The Appropriate ICT theory may be instrumental for the design and implementation of ICT projects in LDCs that takes into account local conditions.

3. Findings and Discussions

3.1. Are There Significant Differences between Schools that Have Integrated and Those that Have Not in Terms of Level and Status of ICT Infrastructure?

In an attempt to provide a solution to this particular question, the researchers employed the use of a Mann-Whitney U test to evaluate the hypothesis testing differences on the level and status of ICT infrastructure between schools that have fully integrated ICT and those that have not fully integrated ICT. Detailed results are illustrated in Tables 1, 2 and 3.

Group Statistics					
	Status of schools	N	Mean	Std. Deviation	Mean Rank
Status of ICT infrastructure	Not fully integrating ICT	280	2.0899	.55462	150.62
	Fully integrating ICT	76	2.8816	.49801	281.22

Table 1: Mann-Whitney Test on status of school and status of ICT infrastructure

	Status of ICT infrastructure
Mann-Whitney U	2833.500
Wilcoxon W	42173.500
Z	-9.854
Asymp. Sig. (2-tailed)	.000
a. Grouping Variable: Status of schools	

Table 2: Test statistics

From table 2(Test statistics) the results indicate significant differences as far as level and status of ICT infrastructure was concerned, z = -9.854, p <.05. Schools not fully integrating had a mean rank of 150.62, which was lower than the mean rank of 281.22 for schools that were fully integrating. The mean rating of schools not fully integrating was 2.0899 which was lower than 2.8816 for schools that were fully integrating. The resultant standard deviation was higher for schools not fully integrating ICT-.55462-as compared to that of schools that were fully integrating ICT which was .49801, (table 6 a). The fact that there is a significant difference between schools integrating ICT and those not integrating (in as far as the level and status of ICT infrastructure is concerned) is an indicator that the difference is not just by chance.

	NOT FULLY INTEGRATING ICT N = 280		**FULLY INTEGRATING ICT N = 76**	
	Mean	Std. Deviation	Mean	Std. Deviation
There are sufficient computers and associated equipment	2.24	.867	2.76	.764
The ICT facilities are reliable and robust	2.08	.850	2.86	.605
There is adequate technical support for the ICT infrastructure	1.96	.800	2.86	.647
Computers and peripherals are suitable for specific purposes they are set to address	2.25	.830	3.11	.645
ICT infrastructure is well maintained in the school	2.16	.809	2.97	.692
All subjects have access to generic and subject specific software and ICT equipment useful for their specification	1.85	.742	2.74	.755
Level/Status of ICT infrastructure	**2.0899**	**.55462**	**2.8368**	**.53037**

Table 3: Distribution of the means by integration status of schools on the level and status of ICT infrastructure

Table 3 above exhibits the statements that were used by the researcher that constituted the variable: level and status of ICT infrastructure for both schools that did not fully integrate and those that had fully integrated ICT into the curriculum. It can be observed from the table that on all the statements in this section, those schools that had not fully integrate ICT into the curriculum had a lower mean and a higher standard deviation as compared to those schools that had fully integrated ICT into the curriculum. The two variables that had a very low mean score for schools not fully integrating ICT were: 'There is adequate technical support for the ICT

infrastructure' (1.96) and 'All subjects have access to generic and subject specific software and ICT equipment useful for their specification,' (1.85). This was an indicator that most respondents in schools that did not fully integrate ICT did not agree to these statements. On the contrary, in the schools that fully integrated ICT, respondents were positive about these statements. From the researchers' observation while undertaking the study, it was true that most of the schools that did not fully integrate ICT lacked both technical support for ICT and generic and subject specific software and ICT equipment useful for their specification. In the respondents' open ended question on management practices that can be put in place for ICT integration, a number of respondents have pointed out the need for technical support to be provided for effective integration of ICT in schools.

Schools that did not fully integrate ICT, from the above table, had a lower mean on the variables: 'There are sufficient computers and associated equipment' (2.34) and 'The ICT facilities are reliable and robust' (2.08). This means were much lower than those of the schools that fully integrated ICT (2.76 and 2.86 respectively). This was an indicator that schools that did not integrate ICT into the curriculum did not have sufficient computers and associated equipment neither were the ICT facilities reliable and robust. Although the schools that had fully integrated ICT into the curriculum tended to have more ICT equipment that were reliable and robust, respondents from the different schools indicated that that they needed more ICT equipment for effective integration of ICT. In the open ended question, most respondents affirmed that procurement for adequate ICT equipment was one of the management facets that would contribute to more effective integration of ICT.

In schools that did not fully integrate ICT, the statements: 'Computers and peripherals are suitable for specific purposes they are set to address' and 'ICT infrastructure is well maintained in the school' scored a lower mean than in schools fully integrating ICT. This was an indicator that for schools not integrating ICT, the opposite of the statements was true while for the schools integrating, the statements were true. From the researcher's observation in the field, it was true that most schools not integrating, the computers and peripherals were not suitable for specific purposes they were set to address. The ICT infrastructure in these schools was not well maintained. Computers were in a state of disrepair while the ICT lab was not well maintained. This was contrary to the schools that had fully integrated ICT. This was an indicator that proper planning had not been done by schools that had not integrated ICT. As can be noted from literature review, a vision for implementation of ICT in school should focus on: Planning, organizing and funding as a major component.

The difference between schools that fully integrated ICT and those that did not fully integrate can thus be observed from the difference means obtained on the various variables that form the level and status of ICT infrastructure in the schools. This was an indicator that schools fully integrating had a higher status of ICT infrastructure than schools not fully integrating ICT into their curriculum. This was authenticated by the researcher's observation of the level and status of the ICT infrastructure in both sets of schools. This was also corroborated by the ICT champions who gave a narration of the differences in the level and status of the ICT infrastructure in both schools that had integrated ICT and those that had nor.

These findings agree with Farrell (2007), whose findings in a survey of the ICT infrastructure that he did in African countries reveal that adequate infrastructure and equipment are key to integration of ICT. The findings of the current study also agree with the findings of UNESCO-UIS (2013), who point out that even if the teachers have been adequately trained for the integration process yet the infrastructure and equipment are wanting, then the integration process cannot be achieved as intended.

3.2 Are there Significant Differences between Schools that have Integrated ICT and those that have not in Terms of Availability and Implementation of ICT Policy?

The researcher used the Mann-Whitney U test to evaluate the hypothesis testing differences on the availability and implementation of ICT policy between schools that have fully integrated ICT and those that have not fully integrated ICT. Detailed results are illustrated in Tables 4, 5 and 6.

	Status of schools	N	Mean	Std. Deviation	Mean Rank
Availability and Implementation of ICT policy	Not fully integrating ICT	280	1.7393	.45192	152.09
	Fully integrating ICT	76	2.4064	.41078	275.82

Table 4: Group Statistics on Availability and Implementation of ICT Policy

	Availability and Implementation of ICT policy
Mann-Whitney U	3244.000
Wilcoxon W	42584.000
Z	-9.378
Asymp. Sig. (2-tailed)	.000
a. Grouping Variable: Status of schools	

Table 5: Test statistics on Availability and Implementation of ICT Policy

From table 5 (Test statistics), the results indicate significant differences, $z = -9.378$, $p < .05$. From table 7a above, schools not fully integrating ICT had a much lower mean (1.7393) in comparison to schools which fully integrated ICT (2.4064). Schools not fully integrating had a mean rank of 152.09, which was much lower than that of schools fully integrating which had a mean rank of 275.82. Schools fully integrating had a higher score on availability and implementation of ICT policy than schools not fully integrating ICT into their curriculum. This was an indicator that there indeed was s significant difference between school that integrated ICT and those that did not in terms of availability and implementation of school ICT policy.

	NOT FULLY INTEGRATING ICT N = 280		FULLY INTEGRATING ICT N = 76	
	Mean	Std. Deviation	Mean	Std. Deviation
School has formulated a comprehensive ICT policy for implementation of ICT integration	1.63	.614	2.46	.552
School's senior management team can articulate school ICT policy	1.76	.653	2.57	.574
Health and safety aspects are entrenched in school ICT policy	1.67	.640	2.46	.599
Management of ICT Resources is well articulated in school ICT policy	1.68	.615	2.53	.577
There is a policy on security and maintenance of ICT infrastructure	1.82	.677	2.49	.600
The Ministry of Education's ICT policy has cascaded to the school level	1.78	.628	1.57	.596
Roles of all stakeholders are articulated in the school's ICT policy	1.69	.582	2.46	.552
The school ICT policy is being implemented	1.79	.606	2.55	.575
Policy on usage of ICT infrastructure exists in school	1.84	.602	2.58	.572
Availability and Implementation of ICT policy	**1.7393**	**.45192**	**2.4064**	**.41078**

Table 6: Distribution of the means by integration status of schools on the availability and implementation of ICT policy

Table 6shows the statements that the researcher used that together formed the variable: availability and implementation of the ICT policy. From the table, it can be observed that the schools that did not fully integrate ICT scored a much lower mean on each of those variables in comparison with schools that fully integrated ICT except on one variable. Schools not fully integrating had a mean of 1.78 on 'The Ministry of Education's ICT policy has cascaded to the school level' while schools fully integrating had a mean of 1.57. Although respondents from both schools were of the view that MoEST's ICT policy had not cascaded to the school level, those from schools not fully integrating believed that the policy had cascaded. However, when the researcher tried to establish if the respondents knew what the policy was, they did not give any response that was indicative of their knowledge of the policy.

Schools that did not integrate ICT had not formulated a comprehensive ICT policy for implementation of the integration process. This variable scored the lowest mean of 1.63 in comparison to schools that fully integrated ICT (2.46). All other variables based on availability and operationalization of the ICT policy were scored lowly by schools not integrating as compared to those fully integrating. These variables included: 'School's senior management team can articulate school ICT policy', Health and safety aspects are entrenched in school ICT policy', 'Management of ICT resources is well articulated in school ICT policy', 'There is a policy on security and maintenance of ICT infrastructure'. 'Roles of all stakeholders are articulated in the school's ICT policy' and 'Policy on usage of ICT infrastructure exists in school'. All these statements had a lower mean in the schools not fully integrating as compared to the schools that were fully integrating. This was an indicator that while schools not integrating did not agree with the variable statements, the schools that were fully integrating tended to agree with the variable statements.

From the documentary analysis of documents found in the schools under study, the researcher, found this area of availability of ICT wanting. Most schools did not have the original files that had been opened during the installation of the ICT facility in the school. For the schools that had this particular file, it had not been updated since the handing over of the project to the school by the ICT champion. It was anticipated that this ICT file would contain the schools ICT policy, vision and mission. All those other variables related to ICT would then be expounded in details in the ICT file. However, this information was missing in most schools. The ICT policy would guide on the effective implementation of the integration process. This would probably explain why most schools have not integrated ICT into the curriculum. The fact that head teachers were running schools which had received funding for development of ICT infrastructure was an indicator that they were not even able to follow five phase point elucidated in the theoretical framework which would aid the integration process.

These findings are corroborated by Hennessy et al (2010), who in their study on ICT policies recapitulate that ICT policies provide a rationale, a set of goals and a vision of how education systems work and how they can benefit students, teachers, parents and other stakeholders. ICT policies provide guidance and failure to have and implement them means that individual schools and classroom innovations would not be sustained.

3.3. Are there Significant Differences between Schools that have Integrated ICT and Those that Have not in Terms of School Leadership?

The researcher used Mann-Whitney U test to evaluate the hypothesis testing differences in school leadership between schools that have fully integrated ICT and those that have not fully integrated ICT. Detailed results are illustrated in Tables 7, 8 and 9

	Status of schools	N	Mean	Std. Deviation	Mean Rank
School Headship	Not fully integrating ICT	280	2.3464	.48893	150.86
	Fully integrating ICT	76	3.0829	.48315	280.34

Table 7: Group Statistics on School Headship

	School Headship
Mann-Whitney U	2900.000
Wilcoxon W	42240.000
Z	-9.750
Asymp. Sig. (2-tailed)	.000
a. Grouping Variable: Status of schools	

Table 8: Test statistics on school headship

Based on table 8 (Test statistic), the results indicate significant differences, z = -9.750, p <.05. Schools not fully integrating had a mean of 2.3464 and mean rank of 150.86, while school fully integrating had a mean of 3.0829 and a mean rank of 280.34. The standard deviation for schools not fully integrating was .48893 while that of the schools that had fully integrated was .48315. Schools fully integrating scored highly on school leadership than schools not fully integrating ICT into their curriculum. The difference in the mean scores on this particular variable is an indicator that the difference between the two schools was significant.

	NOT FULLY INTEGRATING ICT N = 280		**FULLY INTEGRATING ICT N = 76**	
	Mean	Std. Deviation	Mean	Std. Deviation
School head has vision for ICT integration	2.67	.683	3.46	.502
School head is ICT competent	2.51	.790	3.33	.500
School head is committed to ICT integration	2.55	.712	3.39	.591
School head influences other members of staff to integrate ICT	2.53	.762	3.39	.568
There is a clear structure and process for coordination and management for curriculum use of ICT	2.15	.741	2.82	.626
School head seeks for collaboration with other stakeholders on matters of ICT	2.18	.737	2.86	.778
There are visible and practically demonstrable actions of school head regarding ICT	2.28	.766	2.87	.789
School head delegates some roles to members of staff regarding ICT integration	2.28	.762	2.82	.812
Parents are informed about the expenses and importance of implementing ICT by the school head	2.27	.712	2.96	.662
Different stages in the process of ICT integration have been recognized and planned for by school head	2.06	.708	2.93	.736
School Headship	**2.3464**	**.48893**	**3.0829**	**.48315**

Table 9: Distribution of the means by integration status of schools on School Headship

Table 9 shows the mean score and standard deviation of the variables that were considered by the researcher in school leadership. Suffice to point out that schools that were not fully integrating ICT had a lower mean on each of these variables under study as compared to the schools that had fully integrated ICT. Out of the ten variables that constituted school leadership, there were three that had a very low mean for the schools that were not integrating ICT. These included: 'Different stages in the process of ICT integration have been recognized and planned for by school head' (mean of 2.06), 'There is a clear structure and process for coordination and management for curriculum use of ICT' (mean of 2.15) and 'School head seeks for collaboration with other stakeholders on matters of ICT' (mean of 2.18). The fact that these variables had a very low mean was an indicator that for the schools that had not integrated ICT, the opposite of these statements were true. From the researcher's observation in the in the field, it was true that planning for ICT had not been done at the school level as there were no records to indicate the same. Most schools did not avail any records that revealed that there was a clear structure and process for coordination and management for curriculum use of ICT. While these records were missing, it was not possible to anticipate a coordinated management of the implementation of the integration process.

This finding agreed with Kozma (2003), who pointed out that teachers in schools where ICT planning was done were more likely to integrate ICT as compared to those where ICT integration was not planned for. In the open ended question, most respondents pointed that there was need for a structured management for the coordination of ICT integration process. The head teachers of schools that did not integrate ICT had done very little to seek collaboration with other stake holders on issues of ICT. Indeed, many respondents did not out that the stake holders were not aware of the ICT programmes in the schools. For the schools that had fully integrated ICT, the high mean scores on these statements were an indicator they did not have major issues on these variables. They agreed with the truth value of the statements. Some authors have argued that the first important factor in ICT integration is the development of a shared vision concerning how ICT is to be used for teaching and learning (Hughes & Zachariah, 2001; Otto & Albion, 2002). Unless this is done by the school leadership, the implementation progress may decline at some point. School leadership is instrumental in actualizing the progress of growth and implementation of ICT as illustrated in the theoretical framework.

From the table above, it can be observed that the first four variables that had to do with the vision of the school head, the competence of the school head in ICT, the commitment of the school principal to ICT integration and the school head's influence of members of the teaching staff to integrate ICT had very high mean scores for schools that fully integrated ICT in the school as compared to those that did not fully integrate. This was an indicator that apart from the adequate ICT infrastructure in the school, the head teacher had a great role to play in the integration process of ICT. Even if the school had the requisite ICT infrastructure but the head did not have a vision for ICT, was not committed to integration, was not ICT competent and did not influence his or her members of staff to integrate ICT, the school would still lag behind in the integration process. From the records perused through in schools under study, the researcher observed the most of the heads in schools that did not integrate ICT did not have a vision for its integration and were not fully committed to the integration process. This particular finding was corroborated by Gakuu and Kidombo (2010), who found out in their study that it was not just enough for the school leadership to support ICT integration rather formation of a vision for the ICT integration was more critical in the implementation process. This observation was corroborated by the casual manner in which the school heads in these schools responded to the researcher's queries on issues of ICT integration in the schools. The heads in schools that fully integrated ICT were fully in control of the integration. These heads apart from having a vision for ICT in the schools, the researcher observed that they had a higher level of commitment to the integration process.

In an interview with the sub county director of Education for Kakamega Central, he indeed did corroborate that the heads of schools that had fully integrated ICT delegated some roles regarding ICT to members of the teaching staff and informed parents and other stakeholders on the importance and expenses associated with ICT integration in the schools. This is part of what created the difference between schools that fully integrated ICT and those that did not fully integrate ICT. This is evidenced by the high mean accredited to these variables by the respondents from schools that have fully integrated ICT as can be observed from the table above.

3.4. Are there Significant Differences between Schools that have Integrated ICT and those that Have not in Terms of Teachers ICT Competence?

The researcher made use of the Mann-Whitney U test to evaluate the hypothesis testing differences in teacher ICT competence between schools that have fully integrated ICT and those that have not fully integrated ICT. Detailed results are illustrated in Tables 10, 11 and 12.

	Status of schools	**N**	**Mean**	**Std. Deviation**	**Mean Rank**
Teachers' ICT competence	Not fully integrating ICT	280	2.0486	.47647	144.99
	Fully integrating ICT	76	3.0237	.40261	301.95

Table 10: Group Statistics on Teachers' ICT Competence

	Teachers' ICT competence
Mann-Whitney U	1257.500
Wilcoxon W	40597.500
Z	-11.953
Asymp. Sig. (2-tailed)	.000
a. Grouping Variable: Status of schools	

Table 11: Test statistics on Teachers' ICT Competence

Basing on table 11 (Test statistics), the results indicate significant differences, $z = -11.953$, $p < .05$. Schools not fully integrating had a mean of 2.0486 and a mean rank of 144.99, while school fully integrating had a mean of 3.027 a mean rank of 301.95, (Table 10). This is an indicator that schools fully integrating ICT scored highly on teacher ICT competence in comparison to schools not fully integrating ICT into their curriculum.

	NOT FULLY INTEGRATING ICT N = 280		**FULLY INTEGRATING ICT N = 76**	
	Mean	Std. Deviation	Mean	Std. Deviation
Teachers feel confident in integrating ICT in curriculum	2.26	.733	3.33	.473
Teachers are given the technical and administrative support they require in handling ICT infrastructure	2.06	.642	3.24	.486
There are opportunities for teachers to inform and influence the implementation of ICT use in school	2.12	.688	3.00	.632
There is a system for helping teachers identify their ICT training needs	1.88	.628	2.71	.745
Teachers are motivated to integrate ICT into the curriculum by the school leadership	1.92	.571	2.84	.801
Teachers' ICT competence	**2.0486**	**.47647**	**3.0237**	**.40261**

Table 12: Distribution of the means by integration status of schools on Teachers ICT competence

Table 17 above illustrates the five statements that form the teachers' ICT competence variable and how these statements were rated by the respondents from schools that did not fully integrate and those that fully integrated. It can be observed that schools that did not fully integrate ICT had a lower mean on each of these statements as compared to the schools that had fully integrate ICT which had higher means. From the table above, it can be can be observed that schools that did not integrate ICT did not have a system for helping teachers identify their ICT training needs neither did they motivate their teachers to integrate ICT. From the open ended question, many respondents did point out that one of the main management practice for integrating ICT in the schools was by training of more teachers in ICT.

Most schools that had fully integrated ICT did not have issues with teachers' confidence in integrating ICT, technical and administrative support and teachers being given opportunities to inform and influence the integration of ICT in schools. This finding was in agreement with Peralta and Costa (2007) who found out that teachers with more experience with computers had greater confidence in their ability to use them effectively. On these statements, schools integrating ICT scored a much mean as compared to the schools that did not integrate ICT. The researcher did observe in the field that teachers in the schools that had fully integrated ICT had ownership of the integration process as most teachers were fully involved unlike in the schools that did not fully integrate. From review of literature, it can be noted that successful integration of ICT in schools depends strongly on teachers' training on the technology.

Indeed, Drent&Meelissen (2008) did observe that the level and quality of teachers training has a positive influence on how effective ICT is adopted and used in the classroom. It is therefore the responsibility of the school leadership to plan for the training of teachers in ICT integration if positive results are to be realized. Suffice to point out that according to Peralta & Costa (2007), teachers with technical computer competence influenced their use of ICT in teaching. Thus more exposure to computers and training was needed to make the teachers more confident and comfortable in integrating the same ICT into the curriculum.

4. ICT Infrastructure Management Archetype

Based on the findings of the study, the researcher has developed an ICT infrastructure management archetype that can be used by public secondary school that have the ICT infrastructure and would want to successfully integrate ICT into the curriculum

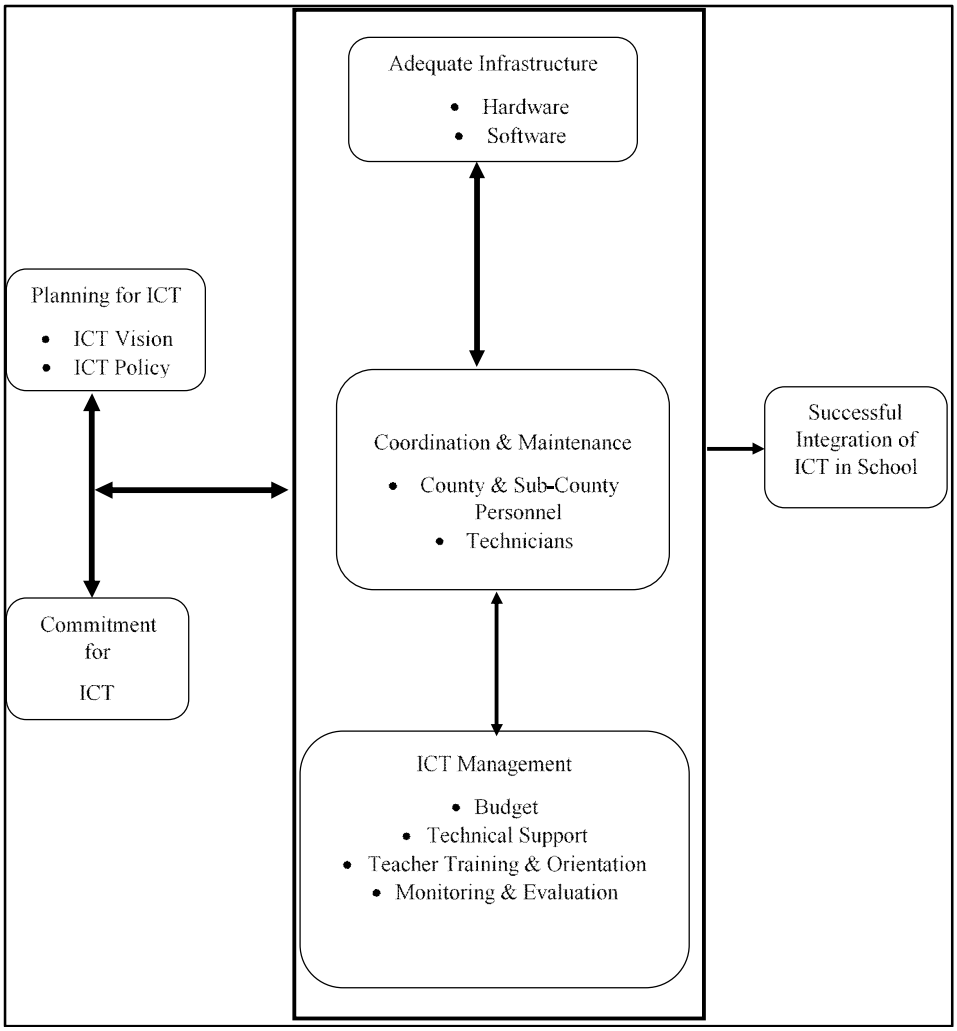

Figure 1: Proposed ICT infrastructure management archetype for successful integration of ICT in public secondary schools

The above figure is a diagrammatic representation of an ICT infrastructure management archetype that can be used by public secondary schools that have the intention of acquiring ICT infrastructure for purposes of integrating ICT into the curriculum. The researcher developed this archetype based on the gaps of lack of adequate planning for ICT integration process and Lack of commitment on the school leadership. There was no evidence of any archetype within the Ministry of Education that could be followed by school leadership intending to integrate ICT into the curriculum. In order for the schools to effectively integrate ICT, there needs to be planning for the integration process without which there can never be successful integration. In planning for this integration, the leadership of the school should include both the BOM and the senior management team of the school.

5. Conclusion and Recommendations

Based on research question two on whether there are significant differences between schools that have integrated ICT and those that have not in terms of: a) Level and status of ICT infrastructure b) Implementation of school ICT policy c) School leadership d) Teachers ICT competence; the following was established:

(i) Research findings revealed that there indeed was a significant difference between schools that have integrated ICT and those that have not in terms of;

(a) The level and status of ICT infrastructure
(b) Availability and implementation of ICT policy
(c) School leadership
(d) Teacher ICT competency

(ii) The null hypothesis stating that there is no significant difference between schools that integrated ICT and those that did not in terms of a) The level and status of ICT infrastructure, b) the availability and implementation of school ICT policy, c) School leadership and d) Teacher ICT competence, was thus rejected and the alternative hypothesis adopted. There was thus a significant difference between schools that integrated ICT and those that did not in terms of a) The level and status of ICT infrastructure, b) the availability and implementation of school ICT policy, c) School leadership and d) Teacher ICT competence.

From the findings of the study, the researchers have the following recommendations:

1. The ministry of education should implement the archetype (Figure I) in order to realize successful integration of ICT
2. Schools should endeavor to formulate school ICT policies to enable them implement the integration process smoothly.
3. Schools should put in place programmes to in service teachers on aspects of ICT integration.
4. Schools leadership should be supportive of ICT integration.

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