A MODEL FOR MEASURING IMPACT OF DIGITIZATION IN SCHOOLS

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DECLARATION

I declare that this dissertation is my original work and has not previously been published or submitted elsewhere for award of a degree. I also declare that this contains no material written or published by other people except where due reference is made and the Author duly acknowledged.

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ABSTRACT

Certainly, digitization has become ubiquitous; now. Almost in all the sectors we routinely interact with digital technologies. In this generation it is elating to be referred as 'digital' and degrading to be referred to as 'analogue'.

In the context of Kenyan secondary school, digitization like a railway track moves in two major planes namely the use of Management information systems (MIS) for purposes of school management and ICT integration for the delivery of the curriculum.

There is great deal more information and research on the use of Information Technology in curriculum delivery in class. But the literature is conspicuously silent on the integration of the two systems that will help effectively create a smart school system, or a digital school. This research undertook to study the extent of impact of the Use of ICT in curriculum delivery and use of MIS in school management.

What lacks is the formal way of assessing the impact of the corporate effect of digitization on both the academic performance of the school and service delivery needed creating. This research undertook to create a model to give a quantitative assessment of the impact of digitization in secondary schools.

This study was driven by desire to evaluate the impact of digitization in our educational institutions. This will help shed light on whether our educational institutions are in sync with digital progress and whether that is producing a measurable difference in terms of academic performance f the learners and the service delivery of the institutions.

The research targeted 35 teachers from seven of the 11 public schools of Makadara Sub- county in Nairobi county. The study sought the teachers input in assessing the adequacy of infrastructure, the reliability and speed of computer systems and the impact that this had on both their students interest and improved academic performance which is referred as slope in this study. The input from teachers solicited through questionnaires was converted into numeric values by use of likert scale from which two measures, the MIS metric index and ICT Integration Index were developed as independent variables. These measures calculated for each of the seven sample schools were compared to the academic performance trend of each of the schools calculated using the MS Excel slope function. The two set of data were found to have a strong positive correlation of 0.49 for MIS Metric Index and 0.63 for ICT integration Index. From the two of these values an empirical model was developed which took the form of multiple regression relation. A manual statistical calculation was used to solve for the constants of the relation thereby arriving at the model. This model can be used to either interpolate or extrapolate the values of school digitization index and its impact of the school.

The reliability and validation of the model was evaluated by use of Cronbach Alpha measure of internal consistency and found to have the acceptable value of 0.735.

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LIST OF ABBREVIATIONS AND ACRONYMS

ICT- Information and Communication Technology

KESSP- Kenya Education Sector Support Programme

KMO – Keizer Myer Olkin

MIS- Management Information System

MOE- Ministry Of Education

NEPAD- New Partnership for African Development

OED- Oxford English Dictionary

UDF- User Defined Fields

UNIVAC- Universal Automatic Computer

CHAPTER ONE

1.0 INTRODUCTION

1.9 Background Of The Study

1.1.1 *History Of Global Digitization*

The Oxford English Dictionary (OED) defines **digitization** as the action or process of digitizing; the conversion of analogue data into digital form.

According to Katz (2015) digitization is the capacity to use digital technologies to generate, process, share and transact information.

The technologies of digitization enable the conversion of traditional forms of information storage such as paper and photographs into the binary code.

Many scholars have suggested that digitizing information puts it into the most useful form. For many, digitization radically transforms the entire landscape everyday life. Certainly, digitization has become ubiquitous; now. Almost in all the sectors we routinely interact with digital technologies. In this generation it is elating to be referred as ‘digital’ and degrading to be referred to as ‘analogue’.

Here are a few milestones in the history of digitization:

1679: Gottfried Wilhelm Leibniz develops the modern binary number system.

1847: George Boole introduces Boolean algebra in *The Mathematical Analysis of Logic*, creating the field of mathematical logic, leading eventually to universal computation.

1937: Claude Shannon submits his master's thesis at Massachusetts Institute of Technology(MIT), establishing the theoretical underpinnings of digital circuits. Shannon showed

how Boolean algebra could optimize the design of systems of electromechanical relays then used in telephone routing switches.

1938: Alec Reeves conceives of the use of pulse-code modulation (PCM) for voice communications, digitally representing sampled analog signals

1943: The SIGSALY secure speech system performs the first digital voice transmission, used for high-level Allied communications during World War II.

1954 General Electric's Major Appliance Division plant in Louisville, Kentucky, installs the UNIVAC I computer, the first business use, of a computer in the United States.

From the 1950s on, with a distinct acceleration in the 1990s due to the advent of the Web, digitization has changed the way we work, shop, bank, travel, educate, govern, manage our health, and enjoy life.

1.1.2 Global Trend Of Digitization

Scholars have explored four key dimensions of convergence related to digitization: infrastructural, terminal, functional, rhetorical, and market convergence.

***Infrastructural convergence*:** Network or infrastructure convergence refers to the physical network of wires that constitute the communication infrastructure. According to (Storsul & Fagerjord (2008) any network can be used to transmit all kinds of digital signal because digitized information can be manipulated and understood by nearly all digital systems. This means that a single physical means like wires, cables, or airwaves may carry services that in the past were provided in separate ways, Pool (1984).

D*evice convergence* refers to how digitization entails the consolidation of multiple media devices into one, Storsul & Fagerjord,(2008). The best example here is the smartphone, which now takes the place of number devices like telephone, computer, camera, audio and video recorder, calendar, calculator, notepad, etc.

Functional convergence in services

The smartphone again offers a suitable example. Not only does the smartphone physically consolidate a number of devices, but it likewise performs a number of functions associated with other mediums. And not only can a single device now perform multiple functions, but can also provide a service that was provided in the past by any one medium like broadcasting, the press, or telephony Pool(1982)

Market convergence: This is consolidating into single unit once separate industrial sectors, including the computing, telecommunications, media and information sectors, Flew(2005).

1.1.3 *Empirical And Contextual Background*

In the context of Kenyan secondary school, digitization like a railway track moves in two major planes namely the use of School Management information systems (MIS) for purposes of school management and ICT integration for the delivery of the curriculum.

Use of MIS

According to Bisaso & Visscher (2005), information technology in educational management is a relatively new field that not only needs in-depth studies on systems utilization in schools but also on their effects on the school processes and maybe outcomes. Demir (2006) further supports this argument stating that whereas there are many studies on the role of information systems on class

and teaching, few studies have been done on the use of them in educational management and their effects on the managers.

The use of information technology in educational management has rapidly increased globally due to its efficiency and effectiveness. In the initial stages of its development, management information systems (MIS) main purpose and usage was to improve the efficiency of school office activities. The most concern was being focused on entry and collation of student data rather than upon data transfer or analysis, Carney (2004). The value of management information came to be recognized during its integration stages.

The positive impact of MIS on school administration and management including better accessibility to information, more efficient administration, higher utilization of school resources, reduction in workload, better time management and improvement in the quality of reports. MIS can provide administrators and teachers with the information required for informed planning, policy-making, and evaluation. MIS have changed school management in the areas of leadership, decision making, workload, human resource management, communication, responsibility, and planning. These systems can assist the school manager in determining the aims of the school, formulating strategic plans, distributing resources, and evaluating staff performance as well as organizational success, Madilah Shah (2001)

ICT integration

The Task force for Education of 2012 noted that among the other issues facing ICT in Education that only about 2% of the schools in the country had networked computer laboratories.

Five years after this report, one is curious to find out whether any of these challenges have been addressed.

With the Government promise to supply laptops to class one pupils in the primary schools, one wonders how much this has accelerated digitization process not only in primary but in Secondary schools as well.

Onyango (2008) notes that the vision of the Government of Kenya is to facilitate ICT as a universal tool for education and training. And in order to achieve this vision every educational institution, teacher, learner and the respective community should be equipped with appropriate ICT infrastructure, competencies and policies for usage and progress.

It calls for transforming teaching and learning to incorporate new pedagogies that are appropriate for the 21st century

It also calls for recognition of the fact that ICT provides capabilities and skills needed for a knowledge-based economy.

He also notes the Ministry of Educations (MOE) mission is to facilitate effective use of ICT to improve access, learning and administration in delivery education programs and services. The principal objective will be to integrate ICT in the delivery of education and training curricula.

Some of ICTs that have been used in the delivery of curriculum include: Electric Board, Audio Cassette, radio for Interactive radio Instructions (IRI), Video/TV-Learning, Computer, Integrated ICT infrastructure and Support Application Systems (SAS).The major challenge in respect to this component is limited digital equipment at virtually all levels of education. While the average access rate is one computer to 15 students in most of the developed countries, the access rate in Kenya is approximately one computer to 150 students. Attempts to set up basic ICT infrastructure in primary schools are almost negligible.

But while most secondary schools in Kenya have some computer equipment, only a small fraction is equipped with basic ICT infrastructure. In most cases equipment of schools with ICT

infrastructure has been through initiatives supported by the parents, government, development agencies and the private sector, including the NEPAD E-Schools programme.

One of the main problems is limited penetration of the physical telecommunication infrastructure into rural and low-income areas.

The EMIS Survey (2003/2004) indicated that over 70% of secondary schools and a much larger proportion of primary schools require functional telephones. Indeed, many parts of Kenya cannot easily get Internet services because of the poor telephone networks. About 90% of secondary schools need to establish standard Local Area Networks (LANs) in order to improve sharing of learning resources

Alternative and appropriate technologies for access to Internet resources, including wireless systems remain quite expensive. Indeed, a small proportion of schools have direct access, through Internet Service Providers (ISPs), to high-speed data and communication systems.

While other countries have reported up to 41% of integration of ICT to teaching and learning, the proportion remains substantially low in Africa, Kenya included. Integration aims at the use ICT to support teaching and learning in the delivery of the various curricula to achieve improved education outcomes. Because ICT is interactive media, it facilitates students to develop diversified skills needed for industrialization and a knowledge-based economy. It also allows teachers and learners to proceed at different paces depending on the prevailing circumstances. As a first step, the Ministry of Education has initiated a major ICT project in Secondary schools meant to equip over 200 secondary schools with ICT infrastructure for integration of ICT in

teaching/learning process (KESSP, 2004). Three schools have been chosen in every district of Kenya.

1.1.4 *Gaps In Use Of MIS and ICT In Schools*

Much information on the use of information systems to help improve efficient management in Educational institutions exists. There is great deal more information and research on the use of Information Technology in curriculum delivery in class. But the literature is conspicuously silent on the integration of the two systems that will help effectively create a smart school system, or a digital school. This research undertook to study the extent of impact of the Use of ICT in curriculum delivery and use of MIS in school management and hopefully recommend a model that will help assess the digitization level in an institution.

1.2 Statement Of Problem

Digitization exists to varied extents in secondary schools either at the management or curriculum delivery level. From literature review these two levels have been treated as independent entities. But both engender digitization in the institution! Katz(2015) Defines digitization as the capacity to use digital technologies to generate, process, share and transact information.

The ministry of Education task force of (2012) noted that then only about 2% of the schools in the country had networked computer laboratories.

The limited connectivity, lack of ICT infrastructure have, however, been attributed to a lack of funding for most institutions.

Kart and Koultroumpis (2013) note, there is a strong consensus in literature on the positive impact of computer use, mobile and fixed broadband networks adoption on economic growth ,productivity and welfare.

Thus there is need of to develop appropriate tools for measuring both digitization and its in Educational sector as well in order to find the impact digitization has on the academic performance of a school . This research study set to do just that.

1.3 Research Objective

The General research objective was to develop a model for assessing impact of Digitization in Kenyan Secondary Schools

And specifically the research sought to:

(i) To identify metrics that can be used to assess the impact of Digitization in Secondary Schools.

(ii) To develop a mathematical model that can use the identified measures to assess the impact of Digitization in secondary schools

(iii) To evaluate the effectiveness of the model

1.4 Research Questions

The general research question is whether a model can be developed for assessing impact of Digitization in Kenyan Secondary Schools

The specific research questions were derived from specific objectives and they were as follows:

(i) Are there a there a set of measurements that can be identified and used to assess the impact of digitization in an Institution?

(ii) Can a mathematical model be established that uses the identified measurements to assess the impact of digitization in educational institutions?

(iii) How can the effectiveness of this model be evaluated?

1.5 Operational definitions

Cronbach Alpha: This is a measure used to assess the reliability, or internal consistency, of a set of scale or test items. In other words, the reliability of any given measurement refers to the extent to which it is a consistent measure of a concept, and Cronbach's alpha is one way of measuring the strength of that consistency.

***Digitization*:** At the most basic level digitization is the process of converting analogue information into digital format.In a broader context digitization is defined as the social Transformation triggered by the massive adoption of digital technologies to generate. Process share and transact information. Katz(2015)

***Digital Divide*:** The term describes a gap in terms of access to and usage of information and communication technology. It was traditionally considered to be a question of having or not having access, Compaine ,B.M (2001).

***MIS*:** Waston et al. (1987) describe management information system (MIS) as an organizational method of providing past, present and projected information related to internal operations and external intelligence. In this study it is an aspect of digitization

***ICT Integration*:** ICT is the electronic and non-electronic technologies and infrastructure systems used to create, store, manipulate, retrieve, and communicate or disseminate information. Information and communications technologies are computer based tools used by people to work with information and communication processing needs of an organization. In this study it is an aspect of digitization.

1.6 Motivation Of The Study

By common definition what is referred today as the third world is a section of the humanity that was skipped by industrial revolution. This is a digital age and as digitization furiously progresses in other sectors of the national economy, is the same reflected in our educational institutions?

In many sectors, digital gadgets are used day to day operations in order to provide quality of service to the public via the use of modern day technology. Information technology has also improved customers knowledge about the use of computer and other gadgets through which customers can access various services.

This study was driven by desire to evaluate the impact of digitization in our educational institutions. This was hoped to help shed light on whether our educational institutions are in sync with digital progress and whether that is producing a measurable difference in terms of academic performance of the learners and the service delivery of the institutions. This was hoped to encourage those not faring very well in the digital path to put more effort in that direction.

1.7 Significance Of Study

Do digital differences exist in Kenyan schools? And if they exist do these differences impact on performance of schools both in academic terms and service delivery? Which factors in this case would determine the fact of the digitization of the school or lack of it?

The significance of this research is the possibility of providing a basis of assessing digitization of an institution and providing means of assessing the impact of digitization in service delivery and academic performance.

The findings of this research will benefit the major stakeholders who are the students by creating the necessity of infusing digital systems in their schools. But teachers and school managers too will benefit from this study by encouraging them to integrate ICT and use MIS for more efficient running of their institutions with the awareness that this has far reaching implications in the performance of their institutions..

This study too will benefit policy makers especially the ministry of Education on realizing the crucial effect digitization has on academic performance of the institutions.

1.8 Scope Of The Study

This research limited itself to study the digital functioning of educational institutions and specifically secondary schools. The study also geographically limits itself to the Makadara sub-county in Nairobi. This is due to convenience of access by the researcher. Hopefully the model developed would with modification be extended to other sectors of the national life.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Introduction

This chapter deals with the contribution of various scholars in the research being undertaken. It gives the definitions of the terms used and the various metrics used to measure digitization in various sectors. It gives both the theoretical review which provide the various theories advanced in the field of digitization and the empirical review which provides the research findings in related areas in the local context. This chapter finally provides the conceptual framework which is visual or written product that explains, either graphically or in narrative form, the main things to be studied and the operationalization of the variables in the conceptual framework.

2.2 Theoretical Review

2.2.1 Measures Of Assessing Digitization Impact

Global Digitization index

Digitization encapsulates social transformation triggered by mass adoption of digital technologies that generate process and transfer information. A digitization index originally developed by Booz & Co. Management consulting firm and published in Sabbag et al (2012) gives a global measure of Countries' national performance. This index engenders affordability, reliability, speed, usability and skills.

Affordability is essential and is derived from the relative access costs of providing such access. **Reliability** of networks depends on the annual network investment per subscriber and the faults reported per line.

Speed is predicated by the performance of country level international links.

Usage is a key component of digitization and includes the utilization and adoption of all commercial activities, social media adoption and data usage.

Skills contribute to digitization both in terms of development of local service offerings and usage capacities. The theoretical framework of the index was set up including the factors stated below and their subcomponents.

TABLE 2.1: INDICATORS AND SUB INDICATORS OF DIGITIZATION INDEX

Indicators	Components	Sub-components
Affordability	Residential fixed line cost adjusted for GDP per capita	Residential fixed line tariff (three minute call to a fixed line at peak rate) adjusted for GDP percapita Residential fixed line connection fee adjusted for GDP per capita
	Mobile cellular cost adjusted for GDP per capita	Mobile cellular prepaid tariff (one minute call off-net at peak rate) adjusted for GDP/capita Mobile cellular prepaid one-time connection fee adjusted for GDP per capita
	Fixed broadband internet access cost adjusted for GDP per capita	Monthly residential price for a fixed broadband Connection
Infrastructure reliability	Investment per telecom subscriber (mobile, broadband and fixed)	Mobile investment per telecom subscriber Broadband investment per telecom subscriber Fixed line investment per telecom subscriber
Network access	Network penetration Other penetration metrics and coverage Infrastructure	3G/4G penetration Mobile broadband penetration PC population penetration Mobile cellular network coverage
Capacity	International internet bandwidth Broadband speed	International internet bandwidth (kbps/user) Broadband speed (Peak Mbps, Average Mbps)
Usage	Internet retail e-Government Non-voice services as percent of wireless ARPU	Internet retail as percent of total retail UN web measure index Individuals using the internet Percentage of individuals using the internet Non-voice (data, message, VAS) spending as percentage of wireless ARPU
	Social network visitors	Dominant social network unique visitors per month per capita
	SMS usage	SMS usage per subscriber
Human capital	Engineers Skilled labor	Engineers as a percentage of total population Labor force with more than a secondary education as a percentage of the total labor Force

Source: Adapted from Sabbagh et al., 2012

Statistically valid sub-indicators in each component were selected that are both adequately different from each other and measure accurately the hidden phenomenon.

This process included the principal components and factor analysis of all components.

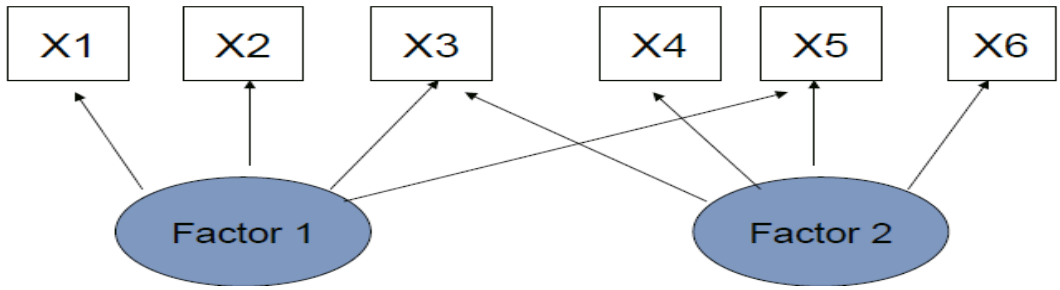
Two tests were performed to assess the adequacy of the sample:

The Cronbach Alpha measure pegged at 0.74 and the Kaiser–Meyer–Olkin (KMO) statistic at 0.75. All subcomponents above 0.71, allowed the developers to proceed with the subsequent analysis of the index.

A KMO statistic was computed for each individual sub-indicator and their sum is the overall KMO statistic. This statistic varies from 0 to 1.0 and should be 0.60 or higher to proceed with factor analysis though realistically it should exceed 0.80 if the results of the principal component analysis are to be reliable. If not, it is recommended to drop the sub-indicators with the lowest individual KMO statistic values, until results rise above 0.60. High values (between 0.5 and 1.0) indicate appropriateness. Values below 0.5 imply not appropriate.

Factor analysis is a statistical method used to explain variability among observed, correlated variables(X_1, X_2, X_3, X_4, ...Xn) in terms of a potentially lower number of unobserved variables called factors.

FIGURE 2.1 PRINCIPAL COMPONENT ANALYSES



Principal components analysis (PCA) aims at identifying components of a variable

Components are aggregates of the variables

Factor Analysis (FA) helps the researcher to discover the number of factors that explain variables. It produces factors that cause variables.

Values closer to 1 are better. If the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy is small, then the correlations between pairs of variables cannot be explained by other variables and factor analysis may not be appropriate

In defining the theoretical framework of the index variables were selected. Each sub-index was normalized, by using the Mean and one standard deviation, and cropping the extremes.

For Affordability sub-index, the inverse of the maximum was used to cap it.

Mobile penetration was capped at a maximum of 100% to prevent over-weighting. For each of the six components a minimum of subcomponents was assigned depending on the scarcity of the available information.

For the Index calculation, a minimum of four components was required. Correlations were initially run between the digitization index and other technology indices to test its ranking value. These technological indices were obtained from various sources.

Network Readiness Index was obtained from (WEF) – ICT, Opportunity Index from (ITU), Digital Opportunity Index from (ITU).

Finally the Keizer-Meyer Olkin measure of sampling adequacy was run indicating the index to be statistically sound.

The following KMO statistics were generated for the various variables

TABLE 2.2: KMO STATISTICS

Variables	**KMO**
Affordability	0.8854
Infrastructure	0.8741
Network access	0.7530
Capacity	0.8154
Usage	0.8394
Human Capital	0.8311
Overall	**0.8202**

Source: Dr Paul L Katz(2013)

With KMO=0.82 the Digitization Index was found to be statistically sound and the index was calculated for 150 countries over the period years 2004 -2011.

Four clusters were identified:

– **Advanced** (Index>50)

– **Transitional** (Index>35&<50)

– **Emerging** (Index>20&<35)

– **Constrained** (Index<20)

In this report Kenya was listed in the emerging cluster.

Academic Performance Index

Computers are seen to have the potential to make a significant contribution to the teaching, learning, and administration in schools. According to Condie et al., (2007), an extensive amount of investment that has gone into introducing information and communication technology (ICT) into schools including hardware, software, networking, and staff development will be considered worthwhile if there is evidence that it has made a commensurate impact on school performance and effectiveness.

In order to appropriately integrate ICT for improved education quality both technology and pedagogy must be addressed in the aspect Koehler calls Technological pedagogic Content Knowledge (TPACK), Koehler (2011). According to Lim, C.P. (2002), inappropriate use of technology in education can lead to negative effects and that should be avoided.

On the other hand effective use of ICTs as teaching learning resources has been associated with significant increase in students' achievement. Students gain confidence as they get engaged by their teachers and sometimes work together with teachers as co-workers in attempt to solve some technological problems, Grabe, M& Grabe, C. (2007). The students also get engaged in activities of searching the web, solving problems and conducting other class activities with aid of technology which they find exciting and complete their own learning tasks which they sent back to the teacher through email.

Effective use of ICTs as teaching learning resources has been found to significantly increase students' achievement ,Bitner, N. et al (2002). And according to So, J.H. & Kim, B. (2009) use of ICT integration also promotes students critical thinking and problem solving skills needed in life. Kaggwa (2003) explained academic performance as the quality and quantity of knowledge, skills, techniques and positive attitudes, behaviors and philosophy that students

achieve. This achievement is evaluated by the mark or grade that student attain in tests or examinations done at the end of the topic, term or year or education cycle. Hence, the quality of the grades and the number of students that pass in various grades determine the level of academic performance. Academic performance determines whether the students will proceed to institutions of higher learning either university or tertiary institutions. Hence, failure in national examinations spells doom for affected students whose lives may become uncertain and full of despair. A student's future education may therefore, be determined by his/her academic performance in the national examinations. Moreover, secondary school administrators in Kenya are under constant pressure to improve their students' grades in KCSE.

A school means score which is an index of the academic performance of the school is calculated on the basis of the aggregate grades of candidates ranging from A to E with A assigned 12 points while E is assigned 1 point. The table below gives the summary of the weighting scale:

TABLE 2.3: GRADING SCALE

GRADE	POINTS	NUMBER OF CANDIDATES
A	12	N_1
A-	11	N_2
B+	10	N_3
B	9	N_4
B-	8	N_5
C+	7	N_6
C	6	N_7
C-	5	N_8
D+	4	N_9
D	3	N_{10}
D-	2	N_{11}
E	1	N_{12}

Source: Author(2017)

The school means score is therefore calculated using the formula:

$$\text{School Mean score} = \frac{\Sigma\ 12N1 + 11N2 + 10N3 + 9N4 + 8N5 + 7N6 + 6N7 + 5N8 + 4N9 + 3N10 + 2N11 + N12}{\Sigma(N1 \ldots N12)}$$

The maximum possible score is 12 while the minimum is 1.

ICT Integration Index

According to Trucano (2005), there is widespread belief that ICT can and do empower teachers and learners, changing teaching and learning processes from being highly teacher-dominated to student-centred. The result of this transformation will automatically be increased learning gains for learners, creating and allowing for opportunities for the development of their creativity, problem-solving abilities, informational reasoning skills, communication skills, and other higher-order thinking skills. In the 21st century, there are basic skills and competencies which an individual is expected to possess for optimal functioning and survival in the digital age. These skills are centered on the effective utilization of ICT in learning and performing other daily routine activities, thus making room for lifelong learning. This being the case, no effort should be spared in making sure that classrooms are ICT driven through its integration in instruction. And according to Willis(2001), two things are involved when we talk about integration of ICTs in effective instructional delivery in other to prepare the pre-service teacher to use technology in teaching. The first is general computer literacy (operating system, word processing, spreadsheet, and database) and telecommunication. The second is professional literacy- a basic understanding of how computer and related technology can be used in education, as well as specific novice skills for integrating technology into the curriculum.

A combination of computer literacy and professional literacy in a conducive-learning environment will invariably enhance the performance of the learner. Attainment of enhanced

learning is highly dependent on the will and competencies of the teacher in performing his duties. Given the role education plays in the development of any nation, Kwache (2007) notes the indispensability of the school in the growth of an ICT learning culture of any country. He maintains that the school should offer efficient leadership in ICT integration through research, modeling of effective integration of ICT and provision of opportunities for professional development of citizens of a country.

Market researchers ask people to describe a service using verbal or numeric scales with words that measure attitudes.

According to Nick Hague and Paul Hague (2017 people are used to the concept of rating things with numerical scores and these can work well in surveys. Once the respondent has been given the anchors of the scale, they can readily give a number to express their level of satisfaction. Typically, scales of 1- 5 are used where the lowest figure indicates extreme dissatisfaction and the highest shows extreme satisfaction.

A Likert scale can be used to rate the level of satisfaction as expressed below:

TABLE 2.4: LIKERT SCALE

RATING	LEVEL OF SATISFACTION
5	Very dissatisfactory
4	Dissatisfactory
3	Neither
2	Dissatisfactory
1	Very dissatisfactory

Source: Author(2017)

2.2.2 Related Models For Assessing Digital Impact

Industrial Digitization Index

Dr. Roman Friedrich et al developed this index which was published by Booz & Company in 2011. The Industry Digitization Index is derived from a wealth of data gathered by Eurostat, the European Union's statistical agency, under its 2011–15 information society benchmarking framework. Among other dimensions, the program captures data on how many companies (of the total number of companies with 10 or more employees) use or have deployed various elements of digital infrastructure, tools, platforms, and management capabilities and policies.

In creating the index, they began by dividing the data into four separate factors, each of which is defined by several sub-factors and components. The four dimensions summarize the following underlying data points:

Digital input: The extent of digital processes in the procurement stage of the business, including data points regarding the use of computer networks as well as electronic transmissions suitable for automatic order processing.

Digital processing: The degree to which processes are integrated, both internally and with external partners. The internal integration sub-factors include data points regarding the existence and use of digital technologies such as enterprise resource planning and customer relationship management, as well as data points regarding the use and purpose of internal information sharing with different organizational functions like accounting, inventory management, and production and services management. External integration comprises such activities as electronic data interchange, including the electronic transmission of data with business partners, public authorities, and financial institutions, as well as activities like supply

chain management, which includes the use of electronic data transmissions to and from business partners both upstream and downstream.

Digital output: The importance of digital processes in the sales function, including the use of computer networks as well as electronic transmission of data suitable for automatic sales processing.

Infrastructure*:* The sophistication of the underlying IT technology, focusing on the presence and use of computers and computer networks (wired and wireless) as well as the presence and type of connection to the Internet, including the use of fixed and mobile broadband or other fixed connections, such as cable or leased lines.

Then, by logically aggregating the results of the data collected for each factor within each industry, they were able to construct both the overall index and a deeper understanding of the progress each industry has made in each of the four factors. Based on this index 3 clusters were generated namely, ***Leading, midfield and lagging***.

At the leading level, the top three sectors in terms of industry digitization, index from 47-53, are financial services and insurance, computers and electronics, and media and telecommunications.

Down at the bottom of the list, digitization index (31-39) on the other hand, are the labor-intensive, old-economy sectors like hotels and restaurants (hospitality), construction, and real estate, rental, and leasing. The position of each of these can be explained by the relative simplicity of their value chains; the high degree of hands-on, on-site, personal interaction required by the way they do business; the often lower affinity for digital technology among their labor pools; and their fragmented nature. Taken together, these characteristics ultimately reduce

these industries' appeal to digital suppliers — but by the same token suggest that digitization offers the potential for these sectors to make great strides in pushing efficiency and customer convenience.

Industries in the middle of the pack, such as utilities, consumer goods, and transportation and logistics were positioned in the midfield cluster ranging from index 40-46.These are also gaining momentum, a clear sign that technologies such as smart tags, M2M communications, and remote metering have reached sufficient levels of technical maturity and cost-efficiency.

It was found out that not only is there a distinctly wide gap between the digital haves and have-nots, but that gap appears to be growing. The leaders in digitization are moving ahead quickly, while progress among many of the laggards remains relatively slow.

In other words their model showed that the rate of growth of a company is predicated by their level of digitization. Educational institutions were conspicuously absent in these clusters.

The Economic Impact Of Digitization In Europe

The advances of digitization in the European continent have been able to generate substantial economic benefits according to Katz(2015). In order to estimate this impact, the econometric model developed in the context of digitization research was employed.

To understand the economic impact of digitization a correlational view of the index and individual income was first developed.

This model was based on a simple Cobb-Douglas form:

Y=A(t)K1+BL1

Where:

A(t) represents the level of technology progress (in this case the Digitization Index)

K corresponds to the fixed capital formation

L to the labor force

The model stated that 10 point increase in on digitization increases GDP per capita by 0.76%. Digitization was found to have a significant effect on economic output.

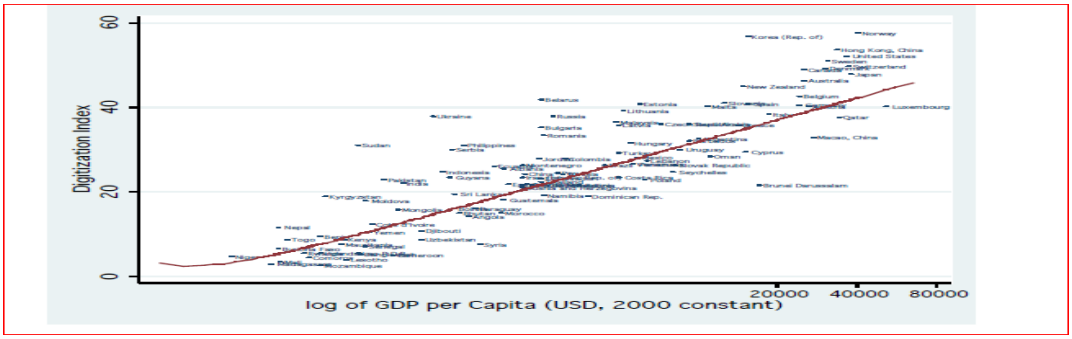
A ten point increase in the Digitization Index has approximately a 2.84% impact on GDP for the Period 2004-2011 resulting in an annualized effect of 0.40%.

The index is a weighted average of different indicators that might be endogenous to GDP like broadband and wireless penetration;

By relying on this model, the contribution of digitization to the growth of the 27 European countries GDP was estimated. In terms of its economic impact, digitization in the Europe 27 countries generated US$ 343 billion in new GDP over the course of 2004-2011

A correlational graph below was obtained as illustrated below.

FIGURE 2.2 CORRELATION BETWEEN DIGITIZATION INDEX AND GDP



Source: Katz (2015)

Capital formation and labor contribution are positive and significant, while digitization is found to have a positive and significant effect at the 1% level, indicating a strong effect on economic output, confirming the correlational view.

2.3 Empirical Review

The ministry of Education In the Sessional Paper No. 1 of 2005 Chapter VII Ministry's policy clearly articulated intentions to integrate information and communication technology (ICT) into education. This is intended to ensure that education and training service provision and delivery utilized modern ICT tools. It identifies two dimensions to ICT in education, i.e. teachers and learners learning about ICT and teachers and learners learning with ICT. Learning about ICT allows learners to contribute to the development of ICT technology and also become ICT literate. On the other hand, learning with ICT is aimed at enabling learners to acquire knowledge and skills that they can use effectively. These two approaches have been assimilated into education in Kenya. The Ministry's policy is to integrate ICT in education and training in order to prepare learners and education managers of today for the 21st century education and knowledge economy.

The implementation of the National ICT Strategy for Education and Training through multi-stakeholder participation in 2006, laid the foundation for developing the necessary capacity for skilled human resource required to achieve Kenya's Vision 2030. This was also in line with the 2010 Constitution.

The Task force for Education of 2012 notes some of the following issues and challenges facing ICT in Education then:

(i) Only about 2% of the schools in the country then had networked computer laboratories.

(ii) The limited connectivity and lack of ICT infrastructure were attributed to a lack of funding for most institutions.

(iii) ICT is a crosscutting investment, and an enabler for efficient delivery of other programmes but obtaining a realistic costing for equipment and activities was a challenge.

(iv) It understood ICT to have three pillars: e-government implementation, EMIS Support and ICT Integration in teaching and learning. Policy and implementation had failed to recognise this and its interrelatedness.

(v) Policy-wise the Ministry needed to prioritize the adoption of ICT at all school levels, ensuring a rollout of providing power and connectivity to all schools. Only then would its use in administration and management, decision-making and planning and in the teaching and learning environment, occur.

(vi) There was a deliberate dumping of old and used computer and ICT equipment to education institutions hence contributing to the problems of e-waste. The development of ICT applications had also resulted in a number of security problems, including those related to system integrity and application use. To coordinate and integrate ICT application, the MoE needed to develop security procedures for equipment, systems and data to prevent computer hacking. In addition, the MoE needed to create a virus-free environment within its offices and educational institutions.

(vii) No ICT curriculum existed at school level or policy and strategic plan to rollout the use of ICT as a teaching and learning tool. An ICT curriculum has been introduced only at teacher training level.

(viii) There was inadequate investment in ICT in teacher training colleges.

(ix) There was lack of ICT skills by practicing teachers.

(x) There was insufficient integration of ICT education in teacher training colleges, primary and at University level.

(xi) There were uncoordinated players in the ICT sector.

(xii) The digital content in the development of curriculum materials had been limited due to lack of financial resources.

The EMIS Survey (2003/2004) indicated that over 70% of secondary schools and a much larger proportion of primary schools required functional telephones. Also that many parts of Kenya could not easily get Internet services because of the poor telephone networks. According to Ogutu J O (2008) about 90% of secondary schools needed to establish standard Local Area Networks (LANs) in order to improve sharing of learning resources.

Basline for a school MIS

Becta (2006) gave recommendation as a baseline for a school's MIS. It looks in brief at 34 different areas that may form part of a school's system and considers the minimum features that each should encompass. Among these are:

(i) Accessibility

The system must be accessible through an intuitive Human Computer Interface (HCI; and support those with disabilities through Disability Discrimination.

As Strickley (2009) suggests many of the current MISs are not designed with the user in mind and many web-enabled options are identical in layout to the non-web version. The different requirements and modes of use of the different access channels must be part of the design.

(ii) Admissions

Admissions for first entry, secondary transfer and in year or casual admissions are all important transfer stages for pupils (Strickley & Allen, 2008). It is therefore critical that the pupil profile is transferred when the pupil moves school.

(iii) Assessment Management

Assessment is key to the school as a measure of its effectiveness, the performance of its pupils and the development and improvement of its learning and teaching.
The assessment software should provide all of the flexibility and usability of the teachers' traditional mark book with the added functionality of a software tool which will support analysis, predicting, standardization and statistical modeling through an Intuitive interface.

(iv) Attendance

A method of easily collecting this data and transferring it is an essential statutory element of a school's MIS. In addition the continued and regular attendance of pupils is critical to their educational achievement and the identification and intervention of poor attending pupils is a vital tool in school improvement. Seamless capture here is the key, at source, via a PDA, laptop, swipe-card or similar.

(v) Authentication

A school's MIS will contain a large amount of sensitive data about children, parents, teachers and other associated personnel. Clearly such a database needs robust authentication before users can access any part of it and in addition strict business rules must be applied that control the exact data items that may be accessed.Access to the system should be at a minimum through user ID and strong,frequently changed, password with additional use of biometrics as an option if appropriate.

(vi) Behaviour Management

Both positive and negative aspects of behaviour should be recordable on the system.
The system should allow the recording of action taken and outcomes. Reports should be available to all appropriate school staff in real-time and analysis tools should be capable of illustrating trends and variables as appropriate.

(vii) Consistent Learner Information

The system should ensure that there is minimal duplication of information and that processes should be automated to avoid errors and inconsistencies. The use of consistent datasets will help to enable consistency and interoperability.

(viii) Data Protection

Compliance with existing Data Protection Acts is clearly essential. It should encompass all data sharing activities and should be generated for all data collection processes such as data collection sheets, emails, web forms etc.

(ix) Information Access

Edit, view and restricted access roles should be available and applied to all fields including User Defined Fields (UDFs). Predefined groups should not be assigned as a default. Access rights should be at field level.

(x) Messaging

The MIS should act as a conduit for the creation, transmission and receipt of all types of messages. These may be telephone voice messages received via any telemetry system and captured by the system; emails from inside or outside of the school intranet; SMS texts sent to an approved school mobile number; emails sent via a web-based email system for parents; short messages sent via the web portal; instant messaging;

Essentially the system should be inclusive to all messaging to and from the school making it unnecessary to move from application to application to access multichannel information and thus reducing the risk of missing vital information.Contact information needs to be prioritised to prevent what could amount to spamming and the creation of groups with similar profiles should be simple to achieve.

(xi) Reporting

An MIS is only as good as the information that can be extracted from it. Ease of use and functionality are key. Simple reports should be menu-based and pre-defined for the users, whilst reports of intermediate complexity should be menu driven or use "wizards" enabling most users to utilise with minimal training.

(xii) Technical Support

The system should be supported through online help, supplier helpdesk, email, telephone and local support unit. Help should be intuitive and available when required but unobtrusive. System upgrades should be accompanied by appropriate explanatory materials including changes log and at regular intervals without excessive software patches applied at a later date.

(xiii) Timetable Management

The timetable is a complex and significant process particularly for a large secondary school. The timetable module should support all of the modeling functionality required including rooms; times; locations; special needs access; travel time; nonstandard timetable cycles etc. It should not be seen as an annual one-off event and should be accessible by staff, parents and pupils in a cut down format through the network and web portal for reference, cover and general information.

(xiv) Workforce Management

The system should enable the management of personnel records, job evaluation, pay scales, training and development, attendance, sickness etc. enabling the generation of statutory returns and linking with financial management to enable a full business model of the school and its staff. Such a sensitive area should have the highest security protocols in place.

(xv) Asset Management

The MIS should be capable of recording and tracking all assets in the school including consumables. The normal reporting and alerting functions should be available to enable good stock management.

(xvi) Coursework Management

The system should support the storage, retrieval, classification and archiving of pupils' coursework materials. These may be those as submitted for examination or pupils' work as part of their day-to-day education or after-school activities.

(xvii) Curriculum Planning

The system must be capable of storing the overall school development plan in an appropriate format. It must cater for all levels from whole-school, through departmental to teacher lesson plans. It must also hold resources required and enable forecasting and modeling for future planning with appropriate links to finance, asset management and assessment etc.

(xviii) Document Management

The system needs to be capable of the storage, retrieval, and classification and archiving of documents including full metadata. Digitization may be through a variety of Methods but the system should be capable of importing and exporting all standard formats.

(xix) Financial Management

Full, partial or limited financial management, to industry standards, should be available capable of being dovetailed with existing over-arching systems from the Local Authority or other systems.

(xx) Library

The MIS should have the option to run a fully functional library system including reference, lending, borrowing, returns, reminders and fines system.

A number of inhibitors to MIS use are evident in the literature; foremost among these are lack of time, lack of confidence or skills, lack of training, lack of senior management support, and lack of technical support.

Also in literature there are researches that show that school managers had problems in using school management information systems.

Kisirikoi(2015) undertook a case study in a school that was reported to have registered an improvement in the school mean score in the Kenya certificate of secondary education(KCSE) from 6.2 to 8.4 between 2007 and 2013 because of using ICT in instructions and practicing learner centered instructional approaches. The secondary school was a boys boarding school near Ngong town, Kajiado county in Kenya. There were 535 students and 28 teachers. Simple random sampling was used to sample 30 students and 18 teachers who participated in the study. The study investigated teachers' computer literacy, the purpose for which computers were used by the teachers in the school, the factors that led to the reported success in the school's use of the computer as a teaching learning resource, the motivation for the teachers specifically in the use of computers and other ICTs as teaching learning resource and impact of use of computer in teaching on students' learning. The study established that the students and teachers were computer literate and were able to manage computer applications for

teaching and learning. The Learning process was found to be practical with learner interactions and activities based learning. Their motivation was desire to teach better coupled with visionary, supportive school leadership. The school was using ICT as teaching learning tool and there was improvement of learning environment and outcomes.

The teachers were required to state the purpose of their use of computer and their responses were as on Table2.5 given below:

TABLE 2.5: USE OF COMPUTERS

Use of Computer	**Uses freq**	**%**
Research, teach, plan, keep records	14	77.7
Teach only	00	00.0
Research only	01	05.6
Keep record only	02	11.1
Plan only	01	05.6
Total	18	100.0

Source: Kisirikoi(2015)

This table suggests a high value of usage indicator in the digitization index. Computers are used to do variety of activities in the school, including Research, Curriculum delivery, and administration.

Teachers were also asked to indicate the impact of their use of ICT in students learning. Table 2.6 below presents the findings.

TABLE 2.6: IMPACT OF USE OF COMPUTER ON STUDENTS' LEARNING

.**The Impact**	**F**	**%**
Raised the student's enthusiasm, interest and creativity	10	56
Student Became Bored	00	00
Improved students' performance	08	44
Total	**18**	**100**

Source: Kisirikoi(2015)

This table above gives a high return for ICT integration index.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Introduction

This chapter begins with the conceptual framework that was adapted which gives the relationship between the independent and the dependent variables. It the gives the operationalization of those variables. Then it discusses the research design that was employed. This research design was informed by the problem that the research addresses, namely to design a model to be used to assess the impact of digitization in educational institution.

It also defines both the target population the accessible populations and the sampling techniques and formulae that arrives at the size of the sample from which data was collected and subsequently analysed. It also discusses the instruments that were used to collect the data and the precaution applied to ensure both the validity and the reliability of the instruments used, sampling techniques and data collection method . It also describes the descriptive measures used to process and analyse the data.

3.2 Conceptual Frame Work

Miles and Huberman (1994) defined a conceptual framework as a visual or written product, one that explains, either graphically or in narrative form, the main things to be studied—the key factors, concepts, or variables—and the presumed relationships among them. For this reason, the conceptual framework of the study is the system of concepts, assumptions, expectations, beliefs, and theories that supports and informs the research design and is a key part of it.

The variables examined in this study included Academic improvement index(or slope), ICT integration and School Management Information system (MIS). The existence of MIS and ICT integration in an institution is taken to directly indicate the existence of digitization in the institution.

The Level or index of digitization is determined by the global digitization indicators namely: affordability, reliability, speed, usability and skills.

Academic performance

Kaggwa (2003) explained academic performance as the quality and quantity of knowledge, skills, techniques and positive attitudes, behaviors and philosophy that students achieve.

.The Academic performance of a school is expressed by the schools mean score in the KCSE exam.

School category was found to be significant and can be used to predict students' performance in mathematics.

This result was in accordance with that of Odhiambo (2006) and Yeya (2002) who observed that urban schools are not badly hit by teacher shortages as many prefer teaching in urban areas and also noted that students with impressive marks avoid day schools in favor of boarding schools.

Since different categories in school exist in the sub- County ranging from National to CDF schools. Stratified random sampling procedure will be used to take into account the difference in performance index owing to the differences in the categories of the schools. Proportionate allocation of sampling fraction or percentage is used to determine the number of units to be drawn from each stratum.

This study took this as the standard measure of academic performance of a school. It did not however use the mean score of the school per se as this is also determined by the entry behavior of the students in the various schools. District schools for instance may not be expected to compete with National schools in mean scores. To even the playing field an improvement index was used computed over six years using an MS excel statistical function called **slope.**

ICT Integration Index

. ICT Integration in this study was expressed by teachers opinion on the effectiveness of the ICT services availed in the institution.

The ICT Integration index was therefore expressed by factors such as: Learners interest, Learners performance improvement, digital systems ease of use and digital services availability.

Impact of Digitization

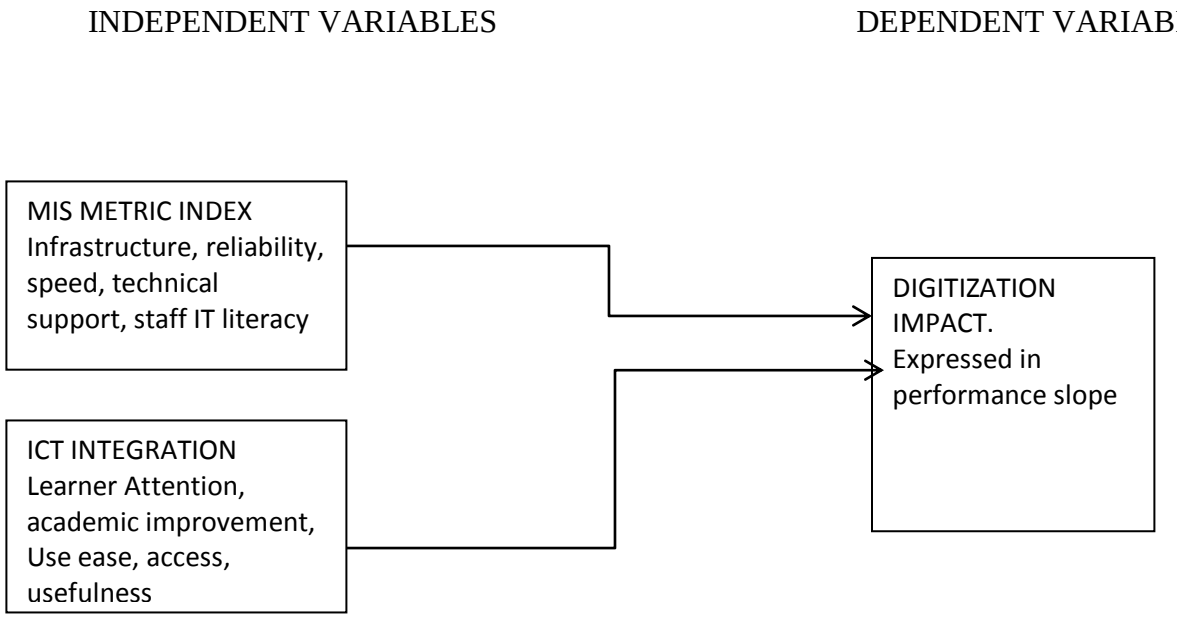
In this study the relationships studied were on the one hand between MIS and ICT integration in the school (as independent variables) and the slope of academic performance(a dependent variable) which is a measure of the **impact** of digitization in the school. If the data set of academic slopes of the various schools under study was to be found to have positive and high correlation with the data set of their MIS Index and ICT Index,a mathematical relashionship would be established. A model would also be developed from this relationship which would require to be subjected to validation.

A mathematical relationship was proposed to exist between the digitization impact index (Y) which is a measure of academic slope (a dependent variable) and MIS Metric Index(X_1) and CIT integration index.(X_2), both of which are independent variables as given below:

$Y = a + b_1X_1 + b_2X_2$, where a, b_1 and $b_2$are constants.

A diagrammatic relationship between these variables is given below:

FIGURE 3.1 DIAGRAMMATIC REPRESENTATION OF CONCEPTUAL FRAMEWORK



Source: Author (2017)

The tentative theory was that MIS Metric index and ICT Integration Index of a school have direct correlation with academic improvement of a school.

3.3 Operationalization Of Variables

Operationalizing variables simply means deciding range of values for the given variables. A variable must have at least two values. But for the purpose of performing correlation regression the variables will be scaled up to percentages.

3.2.1.1 MIS Metric Index

The MIS Integration index calculation was customized for school level by giving each of the five digitization indicators a discrete weight of five at the maximum and one at the minimum.

The sum of the levels was then expressed as a percentage to the maximum possible sum.

Example:

If a respondent gives the following weights to these indicators:

Affordability= 3, Reliability =4, Processing Speed =4, Usability =3 and Skill =4

Then the MIS Metric Index would be given by

$$X1 = \frac{3+4+4+3+4}{5X5} \times 100\% = \frac{18}{25} \times 100\% = 72 \text{ or simply } 4\,\Sigma X_{1i}$$

A digital Index value would be computed for each of the institution visited and responses elicited from the IT expert in that institution.

3.2.2 ICT Integration Index

The ICT Integration Index calculation was also customized for school level by giving each of the five indicators identified a discrete weight of five at the maximum and one at the minimum.

The sum of the levels were then expressed as a percentage to the maximum possible sum.

Example: If a respondent gave the following weights to these indicators:

Learners interest = 3, Learner improvement =3, Speed of information access =4

Ease of system use =3 and Decision making speed =2

Then the ICT Integration index was given by

$$X2 = \frac{(3+3+4+3+2)}{5X5} X\ 100\ \% = \frac{15X100}{25}\% = 60 \quad \text{or simply } 4\Sigma X_{2i}$$

A ICT Integration Index value was computed by finding the **arithmetic mean** of values computed from individual respondents for each of the institution visited. Responses were elicited from a sample of teachers using the computer systems both pedagogically and administratively in that institution.

A table that provides a summary of how the variables in conceptual framework have been operationalized is provided below:

TABLE 3.1: OPERATIONALIZATION OF VARIABLES

VARIABLE	INDICATORS	METRICS
MIS METRIC INDEX	Affordability Reliability Speed Usability Skill	Likert Scale
ICT INTEGRATION INDEX	Learners interest Learner improvement Speed of information access Ease of system use and Decision making speed	Likert Scale
ACADEMIC PERFORMANCE SLOPE	School Mean Scores	KCSE Grading Scale
DIGITIZATION IMPACT INDEX	MIS Metric Index, ICT Integration Index	Multiple `Regression Formula

Source: Author (2017)

2.5.3 Academic Performance slope

The Academic performance index was a computed gradient of the variation of the mean score over five years. Year 2016 was excluded because of the radically different environment under which KCSE was conducted in the country.

The slope was calculated using Microsoft Excel function called slope which generally gives a measure of the academic performance trend for a school over a given number of years. This was more preferable to using school mean score per se as this depended on the level of entry behaviour of the learners of that school.

TABLE 3.2: EXAMPLE OF SLOPE CALCULATION

SCHOOL MEAN SCORES FROM 2012-2016

2012	2013	2014	2015	2016	Mean(σ)
7.23	7.56	6.73	7.42	7.44	7.276

The value obtained by using the Microsoft Excel slope function is 0.028. This value would be compared against the digitization index by either interpolation or extrapolation of the digital impact assessment model.

This data was obtained from the academic dean or the Principal or from school notice boards.

3.4 Research Design

The research goal was to address the research problem namely to fill the gaps of what lacks in terms of the formal way of assessing the effect of digitization on the academic performance of the school. This research undertook to create a model to give a quantitative assessment of the impact of digitization in secondary schools.

A random sample of a target population was used and questionnaires administered to respondents which mainly constituted teachers sought their assessments on both the degree of

ICT integration in their school and its effect and the efficiency and effectiveness of the computer systems in use in their schools.

The accessible population was public schools in Makadara sub-county of Nairobi County owing of its proximity to the researcher. The Sub-county is located not at an affluent but at middle class area of Nairobi and therefore its public schools are thought to be representative of majority of public schools in Kenya.

Descriptive statistics were used to analyse the data obtained from the respondents. Arithmetic mean measure was used to provide representative response from the various responses in each of the school visited where a uniform questionnaire was served. This was then compared with the academic data of the same school. These sets of data coming from various schools were then subjected to a correlation measure.

3.5 Target Population

According to Mugenda & Mugenda(2003) Population refers to a group of individuals , events or objects having a common observable characteristic. A target population was further defined as a population to which a researcher wants to generalize the results of the study.

The target population is all secondary schools in Kenya using digital systems in their daily operations. The accessible population however is secondary schools in Makadara Sub-county of Nairobi which use digital systems.

3.6 Sampling And Sampling Procedure

Sampling may be defined as the selection or some part of the aggregate or totality on the basis of which a judgment or inference about the aggregate or totality is made, Kothari(2007)

The sampling frame is a list containing all the sampling units which are the elementary units of the group or cluster that may form basis of sampling process.

A sample design is a definite plan for obtaining a sample from the sample frame. It involves techniques and procedure of selecting some sampling units from which inferences of the populations are made.

A simple random sampling method was used in which a sample of size n is drawn in such a way that N members of the population have the same chance of being included in the sample.

3.5.1 Sample Size

In their 1970 article in "Eductional and Psychological measurements" Krejcie and and Morgan(1970) have provided the following formula for estimating the sample size,S needed relative to a population of known size, N for a specified confidence level(e.g 95) associated with a chi- square statistic for one dgree of freedom and the designated degree of accuracy as reflected by the amount of sampling error, d that can be tolerated. They set d at 0.05. The formula is as follows:

$$S = \frac{X^2NP(1-P)}{d^2(N-1) + NX^2P(1-P)}$$

in which S= the required sample size

N = The given population size

P= Population proportion (taken as .50 which yields maximum possible sample size required)

D= the degree of accuracy as reflected by the amount of error that can be tolerated

X^2 = table value of chi- square for one degree of freedom,

Using this formula a table sizes for randomly chosen sample from a given finite population with 95 percent level of confidence is given below:

FIGURE 3.2 SAMPLE SIZES

N	S	N	S	N	S
10	10	220	140	1200	291
15	14	230	144	1300	397
20	19	240	148	1400	302
25	24	250	152	1500	306
30	28	260	155	1600	310
35	32	270	159	1700	313
40	36	280	162	1800	317
45	40	290	165	1900	320
50	44	300	169	2000	322
55	48	320	175	2200	327
60	52	340	181	2400	331
65	56	360	186	2600	335
70	59	380	191	2800	338
75	63	400	196	3000	341
80	66	420	201	3500	346
85	70	440	205	4000	351
90	73	460	210	4500	354
95	76	480	214	5000	357
100	80	500	217	6000	361
110	86	550	226	7000	364
120	92	600	234	8000	367
130	97	650	241	9000	368
140	103	700	248	10000	370
150	108	750	254	15000	375
160	113	800	260	20000	377

Source: Krejcie and Morgan (1970)

The researcher targeed mainly Secondary school teacher directly interacting with the MIS and ICT. They included Academic deans, Computer and Subject teachers.

3.7 Research Instrument

The questionnaire was the choice instrument for collection of data. The popularity of this instrument stems from the fact it has low cost, it is free from researcher bias, it is convenient to reach even respondents who are not easily approachable and large sample can be made use of according to Kothari(2004).

Two types of questionnaires were prepared for the respondents. (See sample in the appendices). The first labeled A is to elicit responses which gives the respondents assessment of the efficiency and effectiveness of their schools MIS. Computer teachers were mainly targeted by this questionnaire. But other school personnel directly interacting with the systems were instrumental. The second questionnaire was labeled B and mainly targeted teachers who integrate ICT in their teaching. An additional form C was used by the researcher to collect information on the trend of performance of the school in KCSE.

3.8 Validity And Reliability Of The Instrument.

Validity is the accuracy and meaningfulness of inferences which are based on the research results- it is the degree to which the results obtained from the analysis of the data actually represent the phenomenon under study, Mugenda and Mugenda(2003).

The researcher made the purpose of the study clear to the respondents to avoid ambiguities and chose the sample of respondents to be as representative as possible. The researcher too assured the respondents of confidentiality.

Reliability is a measure of the degree to which a research instrument yields consistent results after repeated trials. It is influenced by random error in that increase in random error decreases reliability.

To eradicate this this the researcher avoided:

(i) Inaccurate coding

(ii) Ambiguous instructions by pretesting the questionnaires

(iii)Bias

(iv)Using too little a sample

Then the researcher applied Cronbach Alpha measure to test the internal consistency the data captured using the questionnaires. This is discussed in chapter 4.

3.9 Data Collection Procedure

Researcher visited each one of the intended institutions and served the research instruments to the selected respondents and waited for the respondents give their feedback before leaving the station.

The researcher collected data from participants using a survey instrument namely a structured questionnaire.

Each item in the questionnaire was developed to address a specific objective, research question or hypothesis of the study Mugenda and Mugenda(2003). Each item constituted a question accompanied by a list of all possible alternatives from which the respondents select the answer that best describes the situation.

Two different types of questionnaire were used. The first was served to the Institution IT expert to elicit response on the level of digitization of the school. From this questionnaire the institution's digitization index was computed.

The second type of questionnaire was served to the teachers interacting with digital systems in the school either in curriculum delivery or management. From this questionnaire a mean of user satisfaction index of the institution was computed.

Likert type scales were incorporated in the questionnaire. Likert scales are survey questions that offer a range of answer options — from one extreme attitude to another, like "extremely likely" to "not at all likely." Typically, they include a moderate or neutral midpoint.

Options will be ordered as; “Strongly disagree”, “Disagree”, “Undecided”, “Agree” and “Strongly Agree”. The responses are graded from 1 to 5 for purposes of computing most representative response.

For purposes of assessing level of digitization in the institution a complex grid system was employed to collect data from respondents resembling the one given below:

Question: How do you rate the following aspects of the MIS?

TABLE 3.3: RATING OF MIS

	very dissatisfactory	Dissatisfactory	Average	Satisfactory	Very satisfactory	
Adequacy						
Reliability						
Speed						
Technical support						
IT literacy						

Source: Author(2017)

On assessing ICT integration factor a complex grid system was employed to summarize data from respondents:(see in the appendix 4)

Converted Numeric values were entered were entered in the table for purposes of computing the ICT Integration index for the school.

Additionally the researcher had form to collect data on the school mean score over the years digitization has been progressing. As this overtaxed recollection a uniform range of five years were used for all schools. This form was filled by the researcher himself using the information obtained from the station.

3.10 Data Processing and Analysis

For purpose of analysis a Likert type scale was used to give weight to the rating of the various feedback on the attributes of the certain aspect of digitization element. A sample of such scale is given below:

TABLE 3.4: LIKERT VALUE CONVERSION

RATING	NUMERIC VALUE
Very Dissatisfactory	1
Dissatisfactory	2
Average	3
Satisfactory	4
Very Satisfactory	5

Source: Author (2017)

The responses from the questionnaire was transferred into a spreadsheet for quick analysis. Each question number was assigned column one row for each person's answers. The answers were assigned a value or "code" as given in the Likert Scale. Coding is conversion of responses into numerical values.

The researcher went through each respondent's questionnaire in turn, adding in the codes. This data was entered into a spreadsheet. Microsoft Excel has capabilities to display the data in form of charts or graphs depending on the researcher's choice. Formulae was also be inserted in the spread sheet to compute the average value for each response and also a measure of dispersion to calculate the degree of disparity or variation of responses given.

Summaries of responses were graphically illustrated using MS Excel capabilities.

These are given in the next chapter followed by interpretations and discussion of the results

CHAPTER 4

4.0 DATA ANALYSIS, FINDINGS AND DISCUSSIONS

4.1 Introduction

This chapter presents the results and the analysis of the study undertaken. The subtopics are organized around the specific objectives and research questions of the study. The data was obtained from respondents through use of questionnaires. The response rate from the respondents is estimated as well as the demographic data of the respondents. The empirical data obtained from the field by use of questionnaires is presented both in tabular and graphical form. The MIS metric index and ICT integration index are computed for each school. The trend of KCSE performance for the years 2011 to 2015 are presented and from it the academic slope is calculated for each seven sample schools. A correlation coefficient is then calculated comparing the two indices against their academic slopes. The correlations were found to be positive and significant.

4.1.1 Response Rate

The response rate was at 100% owing to the style employed in administering of questionnaires. The researcher served the questionnaires physically to a group of respondents and waited for them to fill them and promptly collected them. The questionnaires were not too detailed so none of the respondents required time to study the questions and then submit back the questionnaires. The researcher also took advantage of a forum organized for science teachers from the Makadara sub-county which brought together averagely 4 teachers from each of ten out of the eleven public schools of the sub-county.

4.1.2 Demographic Information

The only information required from the respondents were the subjects they taught in the schools

The following responses on the subject taught were obtained:

TABLE 4.1 DISTRIBUTIONS OF MAJOR SUBJECT TEACHERS

Major Subject taught	No of respondents	%
Physics	7	25
Mathematics	8	29
Biology	6	21
Chemistry	7	25

Source: Author (2017

But the schools sampled varied in terms of gender of learners. The table below shows the gender distribution of sample schools:

TABLE 4.2 GENDER DISRIBUTION OF LEARNERS IN SAMPLE SCHOOLS

GENDER	NUMBER	%
GIRLS	4	57
BOYS	2	29
MIXED	1	14

4.2 Results Presentations and discussion for Objectives One and research Question one

The specific objective one of this study was to identify metrics that can be used to assess the impact of Digitization in Secondary Schools.

From the literature review certain metrics were identified that were used establish the model.

Becta (2006) gave recommendation as a baseline for a school's MIS. Among the 34 areas that need to be assessed on an effective MIS the researcher picked the following:

(i) **Accessibility** of the system

(ii) **Usefullness** in learners assessment, learners records

(iii)Technical Support from supplier helpdesk

A digitization index originally developed by Booz & Co. Management consulting firm and published in Sabbag et al (2012) gives a global measure of Countries' national performance. Measures that the researcher identified were:

(iv) **Affordability**

(v) **Reliability** of networks which depends on the annual network investment per subscriber and the faults reported per line.

(vi) **Speed** which is predicated by the performance of country level international links.

(vii) **Usage** which is a key component of digitization and includes the utilization and adoption of all commercial activities, government services, social media adoption and data usage.

(viii) **Skills** which contribute to digitization both in terms of development of local service offerings and usage capacities.

From Kisirikoi (2015) case study on the effect of ICT integration on performance of students, the researcher gathered metrics that could be used to gauge ICT integration index. Among these were:

(i) Raised student enthusiasm or learners attention

(ii) Improved student performance.

These formed the basic metrics that were used to establish a mathematical model that would represent the impact of digitization in an institution.

4.3 Results and Discussions for Objective Two and Research Question Two

The specific objective two was to establish a mathematical model that can use the identified measures to assess the impact of Digitization in secondary schools.

Three variables were used two of them independent and one dependent two establish a model for assessing impact of digitization in schools.

4.2.1 Independent Variables

MIS Metric Index

The first independent variable under study was MIS Metric Index generated using five factors which in researcher's view formed the basis of the digitization index. From the questionnaires served to IT experts of the seven schools visited the following responses were obtained which generated their digitization indices. For confidentiality purposes the names of the school are coded.

TABLE 4.3 MIS METRIC INDEX OF SCHOOLS

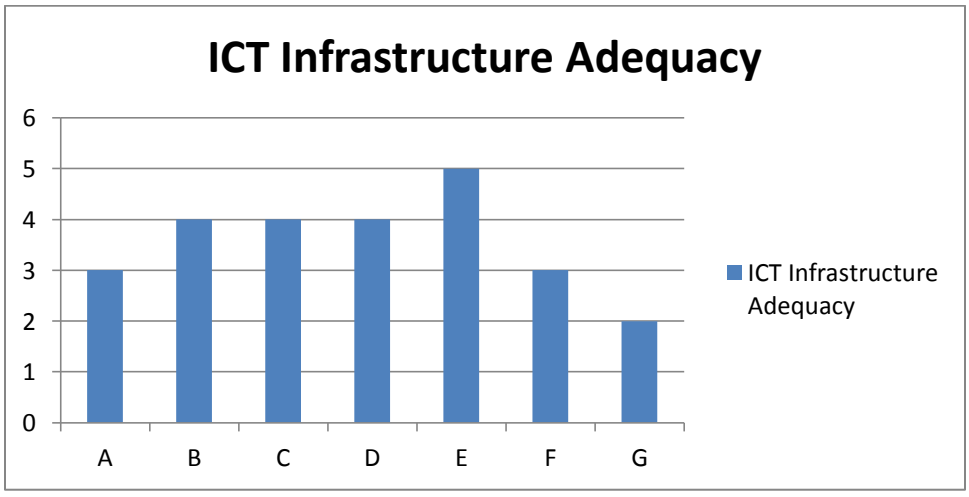
SCHOOL	ICT Infrastructure Adequacy	Systems Reliability	Systems Speed	Technical Support	Staff Computer Literacy	MIS metric index
A	3	3	3	4	3	64
B	4	4	4	4	4	80
C	4	3	4	5	4	80
D	4	4	3	4	3	72
E	5	5	4	4	5	92
F	3	4	4	4	2	68
G	2	3	3	2	3	52

The MIS Metric Index was calculated from the formula $4\ \Sigma X_i$.

For school A, 64 was obtained from the calculation (3+3+3+4+3) x 4+44

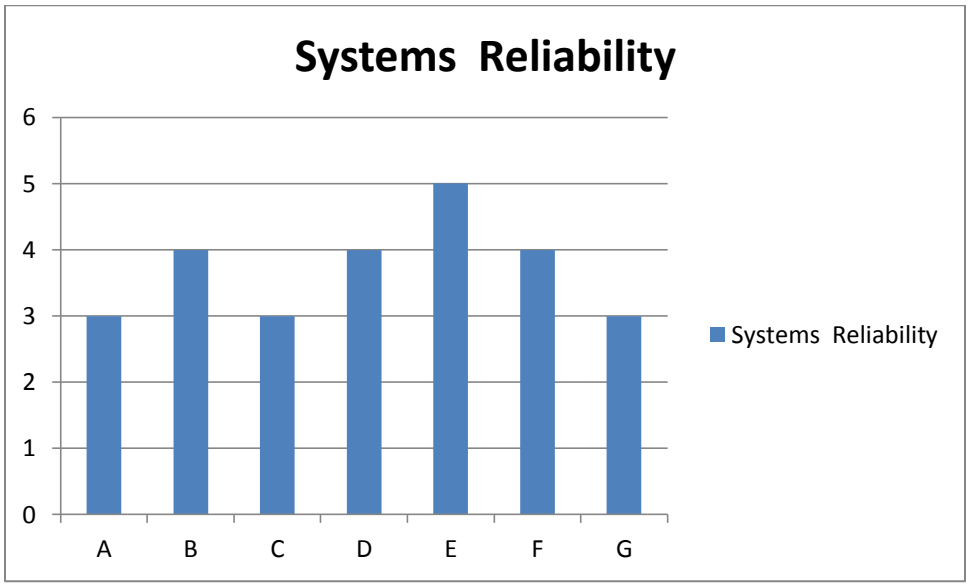
The graphical representation of the comparisons of MIS metric factors for various schools and ultimately the MIS Metric index for each school are given below:

FIGURE 4.1 ICT INFRASTRUCTURE ADEQUACY



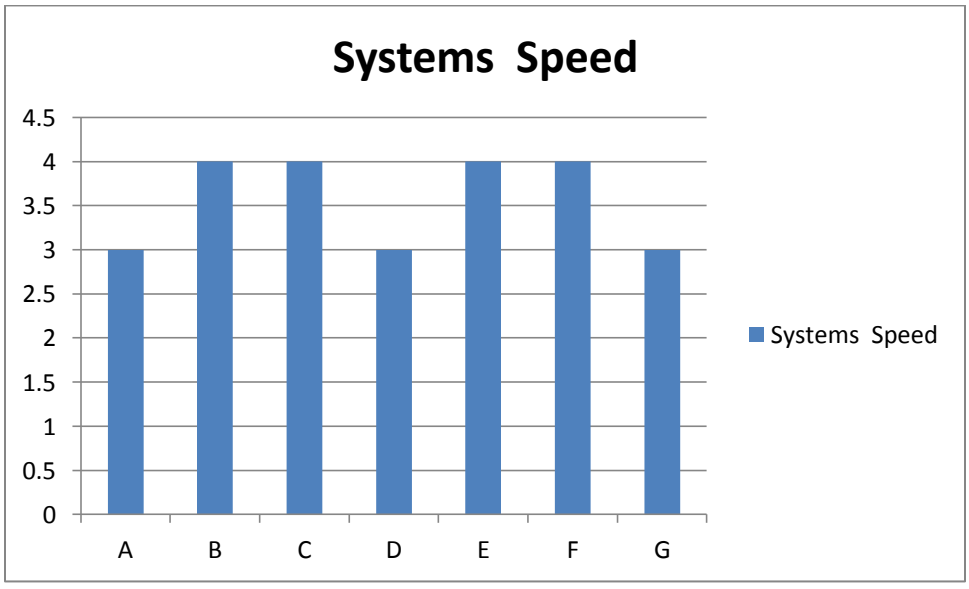
Source: Extracted from TABLE 4.3

FIGURE 4.2 SYSTEMS RELIABILITY



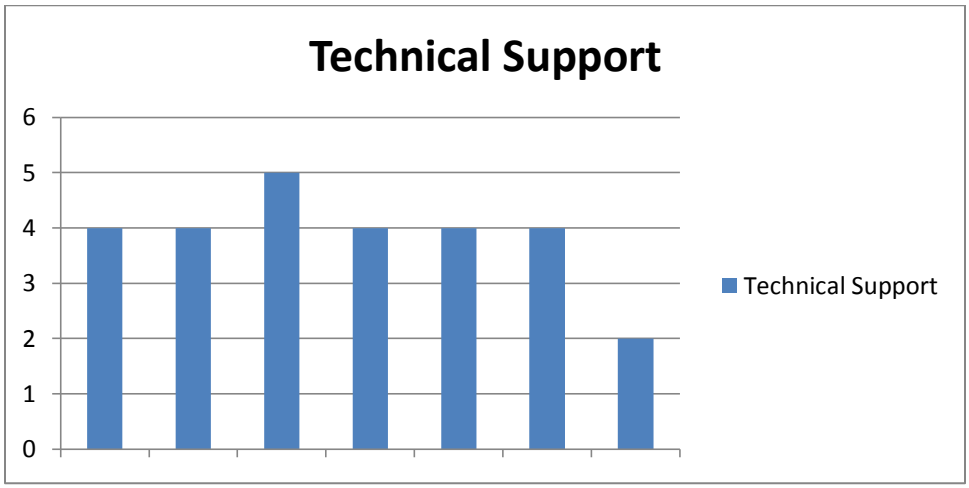
Source: Extracted from TABLE 4.3

FIGURE 4.3 SYTEMS SPEED



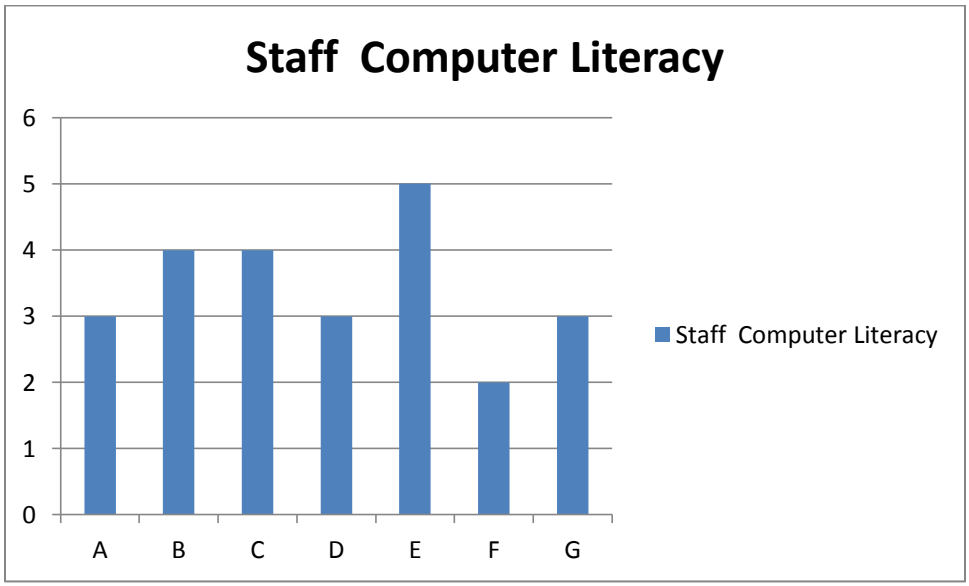
Source: Extracted from TABLE 4.3

FIGURE 4.4 TECHNICAL SUPPORT



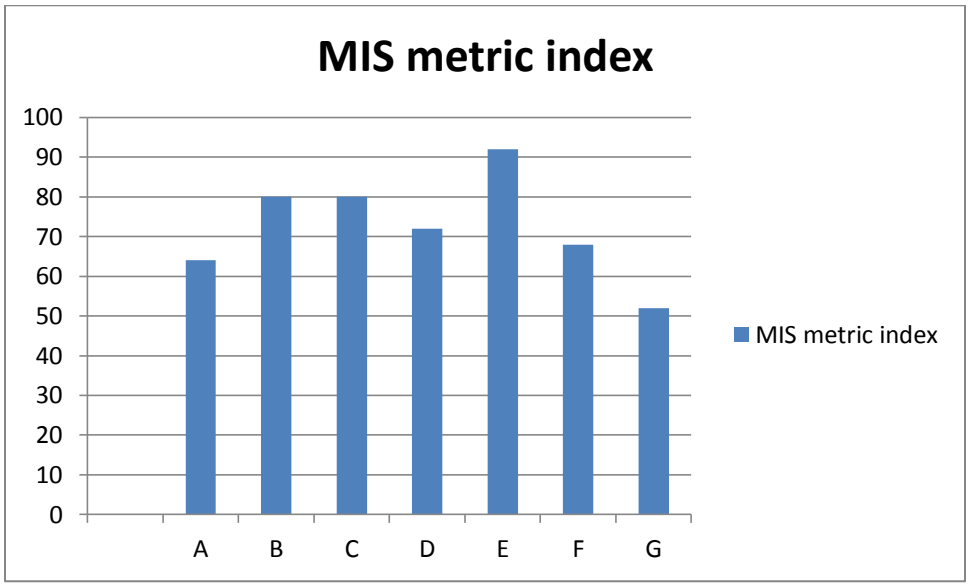
Source: Extracted from TABLE 4.3

FIGURE 4.5 STAFF LITERACY LEVELS



Source: Extracted from TABLE 4.3

FIGURE 4.6 MIS METRIC INDICES



Source: Extracted from TABLE 4.3

ICT Integration Index

On the rating of the effect of ICT integration on the learners' behavior the following responses were obtained. (Columns 1 and 2)

On responses of the Teachers rating of the schools digital system for students' records e.g students marks, timetabling etc. the following responses were obtained and converted to numerical values (columns 3, 4 and 5)

This index was constructed by eliciting responses from a total of 28 teachers , averagely from each of the seven sample schools. The summary tabulated responses from which averaged responses for each school given below:

TABLE 4.4 ICT INTEGRATION INDICES

SCHOOL	Learners Attention	Increased Learners Performance	Speed of system Access	Ease of use of system	Usefulness of the system	ICT Integration Index
A	2	3	3	2	1	44
B	4	4	3	5	4	80
C	5	4	3	3	4	76
D	5	5	4	4	5	92
E	3	2	2	3	2	60
F	4	4	4	3	3	72
G	4	3	2	2	2	52

Source: Author (2017)

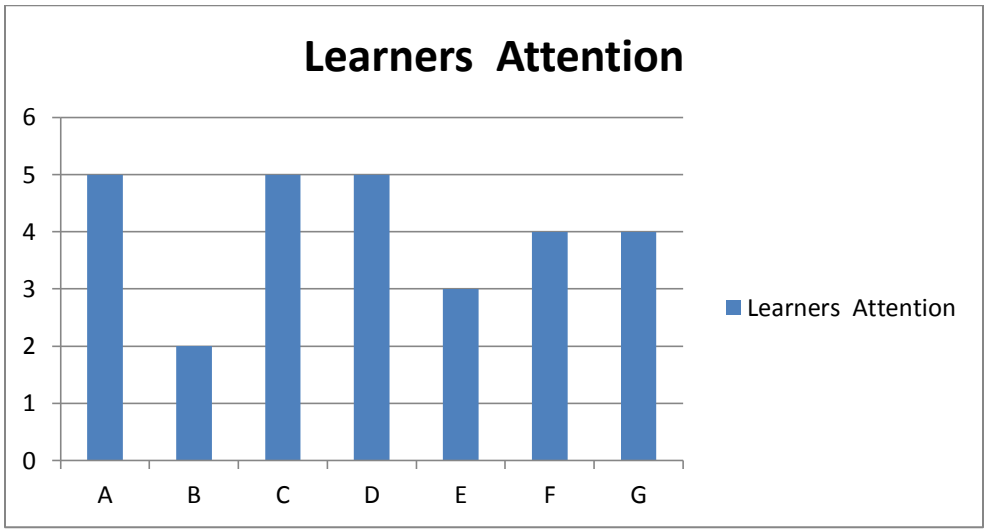
The graphical representation of the comparisons of ICT Integration factors for various schools and ultimately the ICT Integration index for each school are given below:

The CIT Integration Index was calculated by getting representative Likert scale value for each question. This is the same as averaging the values of responds and correcting to the nearest whole number. The ICT Integration index was subsequently calculated thus: For school A, 44 was obtained from the calculation

$$\frac{(2+3+3+2+1)}{25} \times 100\%4=44 \quad \text{Or simply } 4\Sigma X_{2i}$$

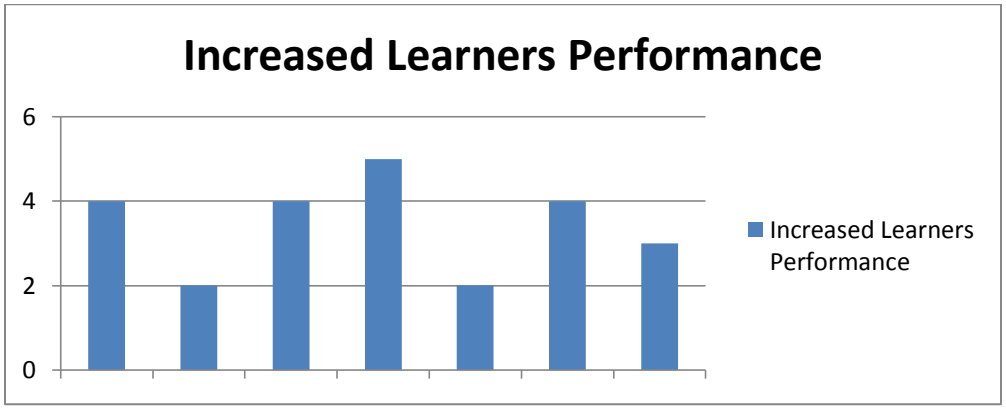
The following bar graphs were extracted from the ICT Integration indices table for the sample school

FIGURE 4.7 COMPARISONS BETWEEN LEARNERS ATTENTION



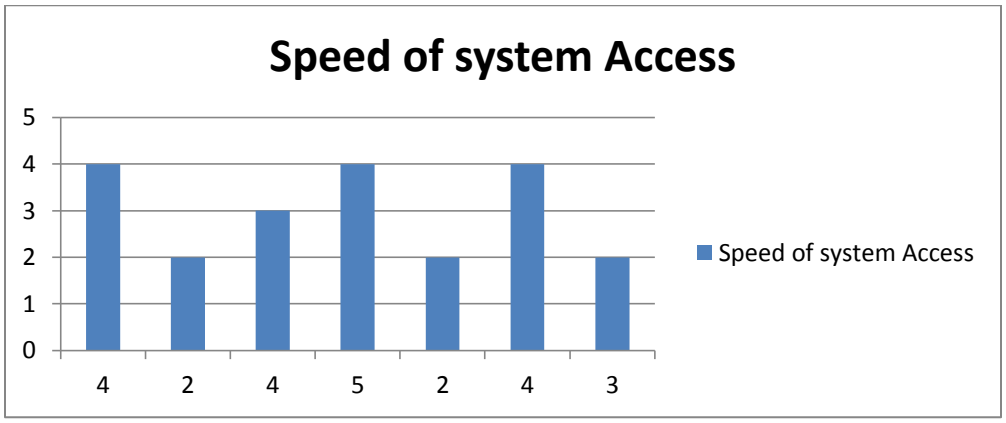
Source: Extracted from TABLE 4.4

FIGURE 4.8 INCREASED LEARNERS PERFORMANCE



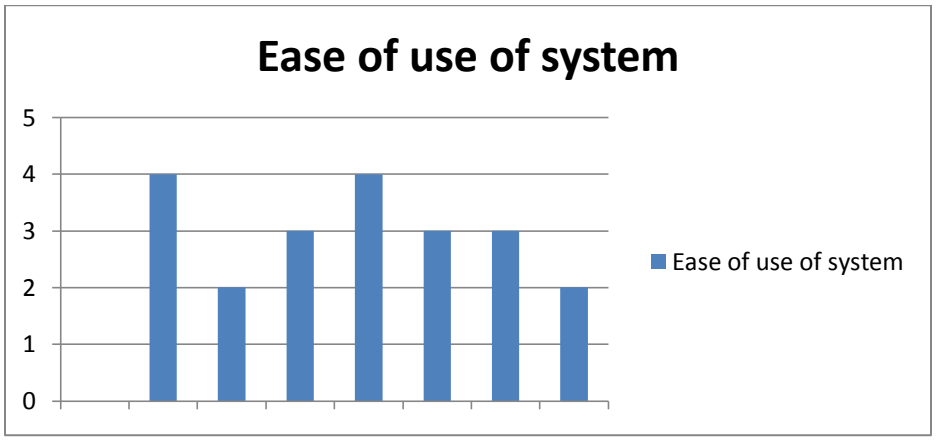
Source: Extracted from TABLE 4.4

FIGURE 4.9 SPEED OF SYSTEMS ACCESS



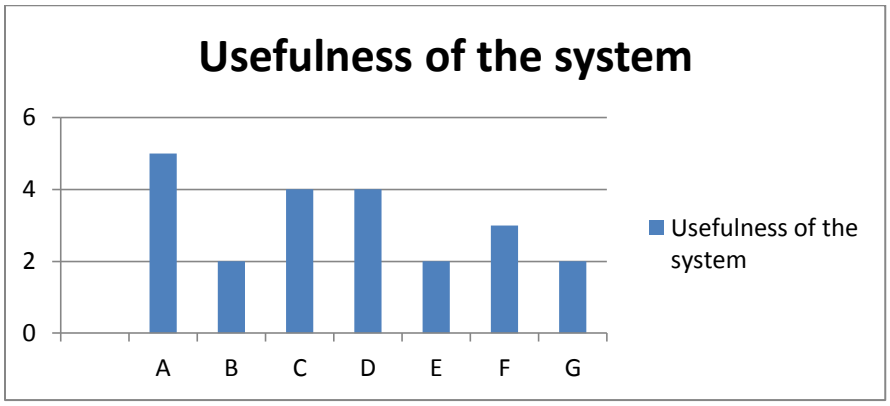
Source: Extracted from TABLE 4.4

FIGURE 4.10 EASE OF USE OF SYSTEMS



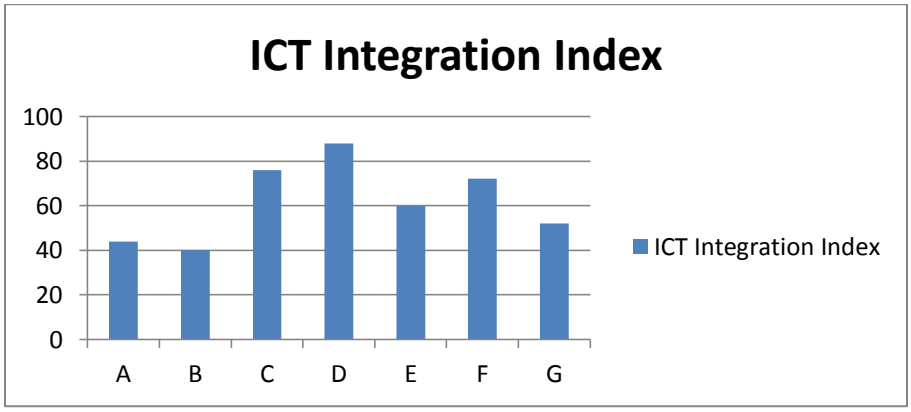
Source: Extracted from TABLE 4.4

FIGURE 4.11 USEFULNESS OF SYSTEMS



Source: Extracted from TABLE 4.4

FIGURE 4.12 ICT INTEGRATION INDEX



Source: Extracted from TABLE 4.4

4.3.2 Dependent variable

Academic performance slope (Digitization Impact)

This measure was taken as a direct measure of the impact of digitization of a school had on the performance of the school. The set of data of slopes calculated from each of the seven schools

was to be subjected to a correlation measure against the set of data of digitization indices obtained from the same seven schools.

The following trend of KCSE mean scores and their graphical representations over 5 years for the sample schools were obtained:

TABLE 4.5 ACADEMIC PERFORMANCE TRENDS FOR SAMPLE SCHOOL

SCHOOL	**2011**	**2012**	**2013**	**2014**	**2015**	**SLOPE**
A	4.742	4.364	5.126	5.084	4.307	-0.01
B	8.945	9.47	9.27	9.431	9.114	0.03
C	6.58	6.64	6.84	7.38	7.78	0.31
D		4.22	3.99	4.54	5.94	0.57
E	6.959	6.43	6.73	7.80	8.26	0.4
F		5.813	5.676	5.679	6.508	0.21
G	4.455	4.25	4.23	4.233	4.664	0.04

Source : Author(2017)

From this data the academic performance slope values were calculated using MS Exel function of "slope'. These values give an indication of the academic performance of the school whether positive or negative.

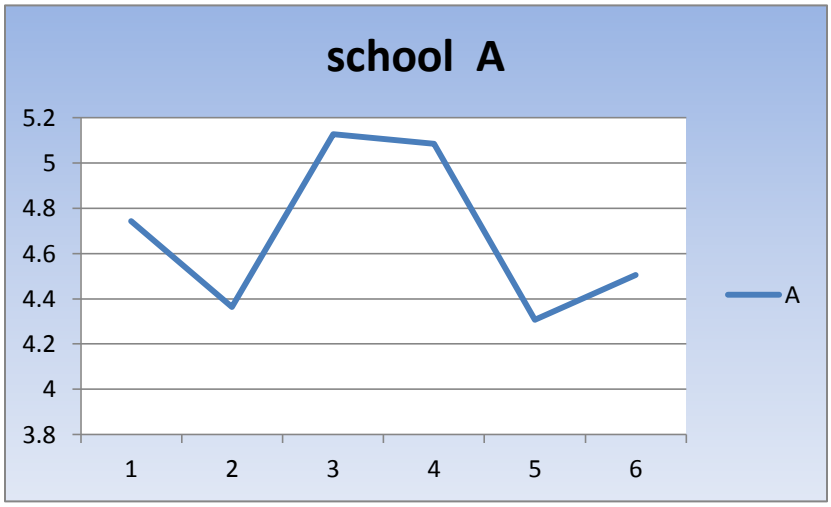
TABLE 4.6 SCHOOLS' ACADEMIC SLOPES

SCHOOL	ACADEMIC SLOPE
A	-0.01
B	0.03
C	0.31
D	0.57
E	0.4
F	0.21
G	0.04

Source: Author (2017)

The graphs for the academic trends of the sample schools which reflect the calculated slopes are given below:

FIGURE 4.13 ACADEMIC PERFORMANCE TREND (SCHOOL A)



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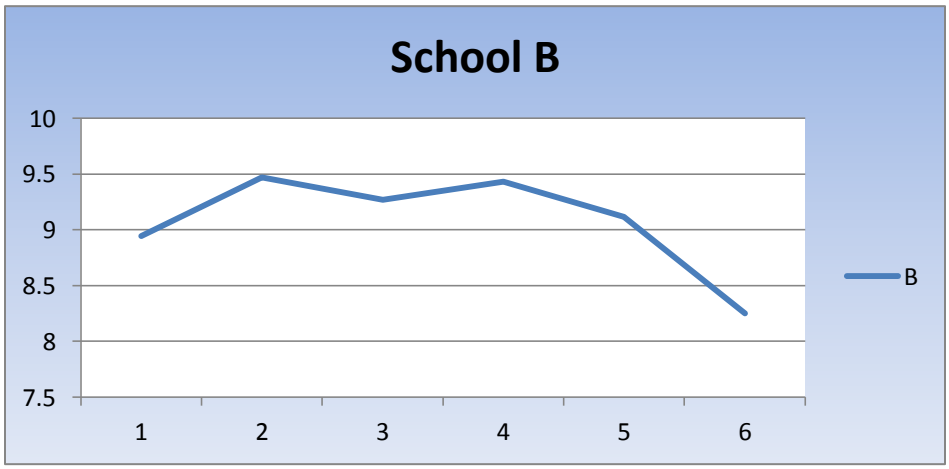
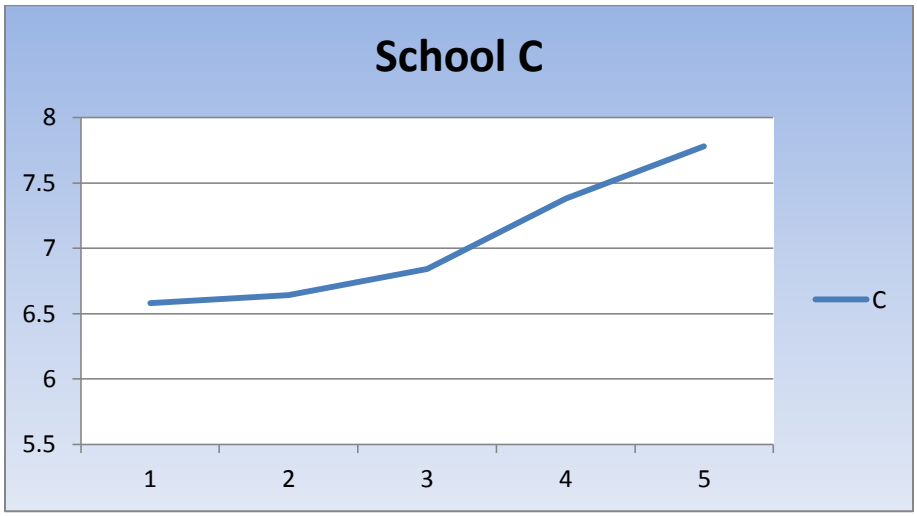
Source: Extracted from TABLE 4.6

FIGURE 4.14 ACADEMIC PERFORMANCE TREND (SCHOOL B)



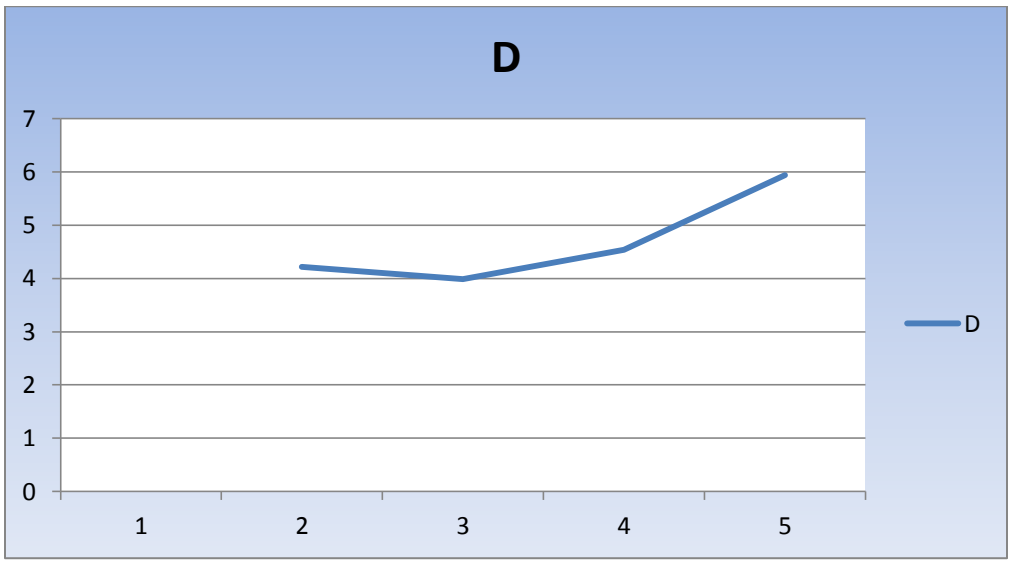
Source: Extracted from TABLE 4.6

FIGURE 4.15 ACADEMIC PERFORMANCE TREND (SCHOOL C)



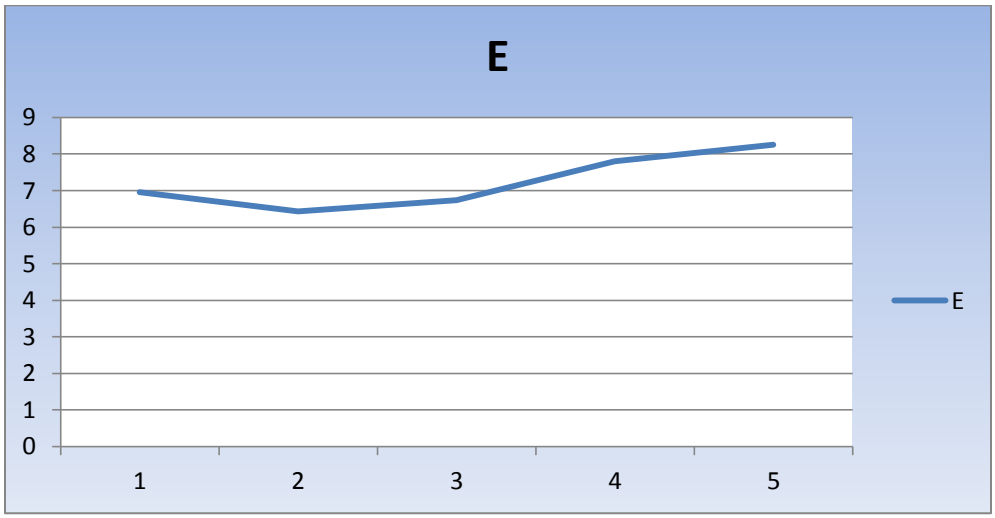
Source: Extracted from TABLE 4.6

FIGURE 4.16 ACADEMIC PERFORMANCE TREND (SCHOOL D)



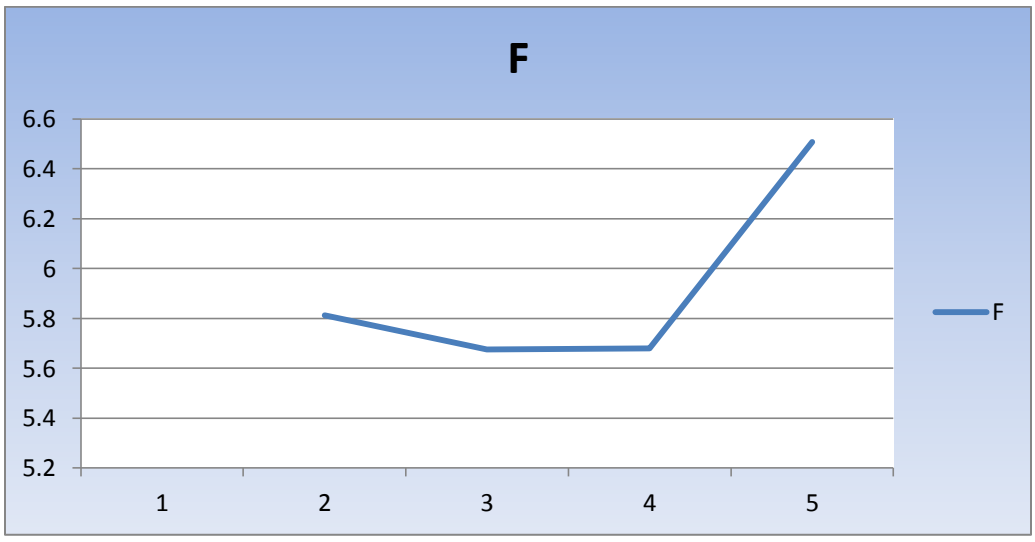
Source: Extracted from TABLE 4.6

FIGURE 4.17 ACADEMIC PERFORMANCE TREND (SCHOOL E)



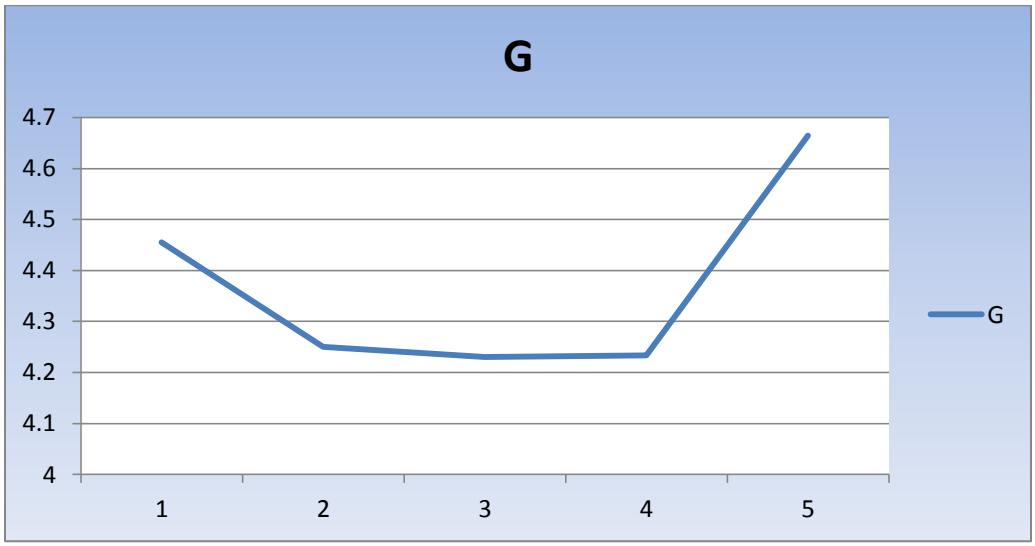
Source: Extracted from TABLE 4.6

FIGURE 4.18 ACADEMIC PERFORMANCE TREND (SCHOOL F)



Source: Extracted from TABLE 4.6

FIGURE 4.19 ACADEMIC PERFORMANCE TREND (SCHOOL G)



Source: Extracted from TABLE 4.6

4.3.3 Use Of Identified Measures To Establish A Model

The set of digitization indices obtained for the various schools were subjected to a correlation measure with the data set of academic performance slope obtained from the same schools. The computation of a correlation coefficient yields a statistic that ranges from -1 to +1. This static tells the researcher the relationship between the two variables. The bigger the absolute value the stronger the association between the two variables.

The direction of the relationship between the two variables whether positive or negative also shows the nature of the association. If the correlation is positive it shows as variable X increases variable Y also increases. But a negative correlation coefficient shows as variable X increases Y decreases and vice versa. Mugenda and Mugenda(2003)

Determining the strength and the direction of of the association between two variables helps form the basis for selecting variables for further statistical analysis.

The set of data of MIS Metric Indices calculated for the seven sample schools was subjected to a correlation comparison with a set of academic performance slope computed for the same seven schools. The following table presents the two sets of values:

TABLE 4.7 MIS METRIC INDEX VS ACADEMIC SLOPE

SCHOOL	MIS METRIC INDEX	ACADEMIC SLOPE
A	64	-0.01
B	80	0.03
C	80	0.31
D	72	0.57
E	92	0.4
F	68	0.21
G	52	0.04

Source: Author(2017)

By comparing the two sets of values a correlation of 0.49 corrected to2 decimal p laces was returned.

The set of data of ICT Integration Indices calculated for the seven sample schools was subjected to a correlation comparison with a set of academic performance slope computed for the same seven schools. The following table presents the two sets of values:

TABLE 4.8 ICT INTEGRATION INDEX VS ACADEMIC SLOPE

SCHOOL	ICT INTEGRATION INDEX	ACADEMIC SLOPE
A	44	-0.01
B	80	0.03
C	76	0.31
D	92	0.57
E	60	0.4
F	72	0.21
G	52	0.04

By comparing the two sets of values a correlation of 0.63 corrected to2 decimal p laces was returned.

According to Kothari (2007) multiple regression equation assumes the form $\mathbf{Y= a + b_1X_1 + b_2X_2}$ **,** where a, b_1 and $b_2$are constants variables X_1 and X_2 being independent variables and Y being the dependent variable. The constants a, b_1 and b_2 can be solved by solving the three normal equations:

$\Sigma Y_1 = na + b_1\Sigma X_{1i} + b_2\Sigma X_{2i}$

$\Sigma X_{1i}Y_i = a\Sigma X_{1i} + b_1\Sigma(X_{1i})^2 + b_2\Sigma X_{1i}X_{2I}$

$\Sigma X_{2i}Y_i = a\Sigma X_{2i} + b_1\Sigma X_{1i}X_{2i} + b_2\Sigma(X_{2i})^2$

The table below represents the variables $X_{1,}$ X_2 and Y where X_1 represents MIS Metric Index, X_2 represents ICT Integration Index and Y is the dependent variable which represents Impact of Digitization, expressed in the measure of the academic slope of carious schools.

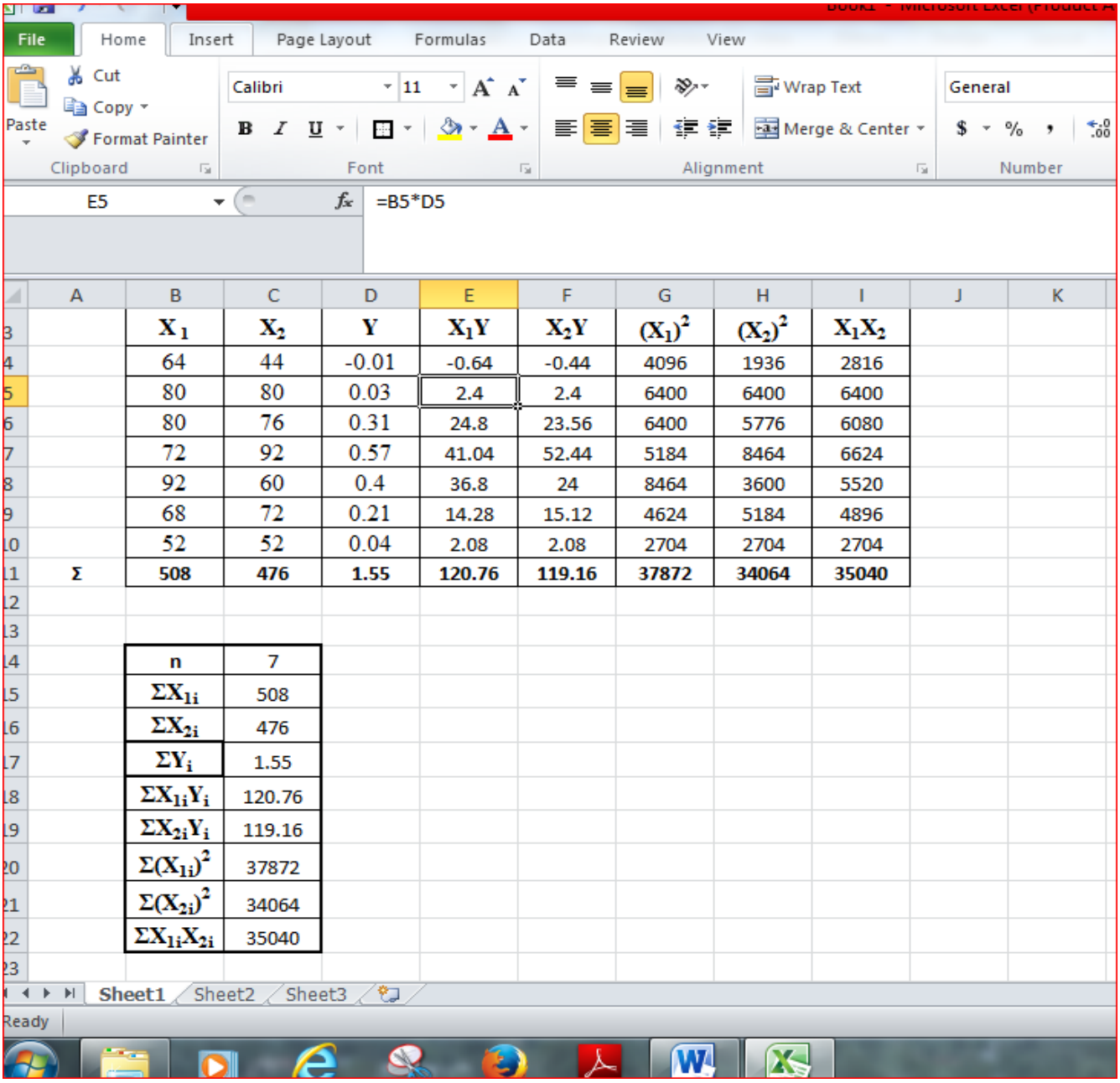
TABLE 4.9: VARIABLES TABLE

X_1	X_2	Y
64	44	-0.01
80	80	0.03
80	76	0.31
72	92	0.57
92	60	0.4
68	72	0.21
52	52	0.04

Source: Author (2017)

The various products and summation values expressed in the three equations above to be used to find the constants a, b_1 and b_2 were computed using excel worksheet as provided by a screen shot below:

FIGURE 4.20 PRODUCTS AND SUMMATION ON EXCEL WORKSHEET



	A	B	C	D	E	F	G	H	I	J	K
3		X_1	X_2	Y	X_1Y	X_2Y	$(X_1)^2$	$(X_2)^2$	X_1X_2		
4		64	44	-0.01	-0.64	-0.44	4096	1936	2816		
5		80	80	0.03	2.4	2.4	6400	6400	6400		
6		80	76	0.31	24.8	23.56	6400	5776	6080		
7		72	92	0.57	41.04	52.44	5184	8464	6624		
8		92	60	0.4	36.8	24	8464	3600	5520		
9		68	72	0.21	14.28	15.12	4624	5184	4896		
10		52	52	0.04	2.08	2.08	2704	2704	2704		
11	Σ	**508**	**476**	**1.55**	**120.76**	**119.16**	**37872**	**34064**	**35040**		
12											
13											

14	n	7
15	ΣX_{1i}	508
16	ΣX_{2i}	476
17	ΣY_i	1.55
18	$\Sigma X_{1i}Y_i$	120.76
19	$\Sigma X_{2i}Y_i$	119.16
20	$\Sigma(X_{1i})^2$	37872
21	$\Sigma(X_{2i})^2$	34064
22	$\Sigma X_{1i}X_{2i}$	35040
23		

Source: Author (2017)

Solving For Constants a, b_1 And b_2

Three resulting normal equations are after substituting the compute values in the spreadsheet are:

1.55= 7a + 508 b_1 + 476b_2…….…….…….(1)

120.76= 508a + 37872b_1 + 35040b_2……(2)

119.16 =476a +35040b1+ 34064b_2……’……..(3)

To solve for the three constants a, b_1 and b_2 the equations are solved simultaneously by first eliminating term a by subtracting equation 1 from equation 2 then by subtracting equation 2 from equation 3 thus creating two simultaneous equations A and B as shown below:

Multiplying equation 1 by 508 and equation 2 by 7 and eliminating term a:

845.32= 3556a + 265104b_1 +245280b_2
787.4 = 3556a + 258064b_1 +241808b_2 -
57.92 = 7040b_1 + 3472b_2
……..(A)

Multiplying equation 2 by 476 and equation 3 by 508 and eliminating term a:

60533.28 = 241808a + 17800320b_1 + 17304512b_2
57481.76 =241808a + 180270072b_1 + 16679040b_2 –
3051.52 = - 226752b_1 + 625472b_2
…….(B)

Solving for b_2 by eliminating term b_1 by addition in the simultaneous equations A and B by multiplying equation A by 226752 and equation B by 7040:

1313336 = 159632000b_1 + 78727600b_2
21482700.8= -159632000b_1 + 4403322880b_2 +
22796036.8= 4482050480b_2

Hence b_2 = 0.005086073194

b_2 = 0.0051(2sf)

Substituting for b_2 in equation A and solving for b_1:

$57.92= 7040\ b_1 + 3472 \times 0.005086073194$

$7040b_1 = 57.92-17.65884613$

$7040\ b_1= 40.26115387$

$b_1= 0.005718913902$

b_1= 0.0057(2sf)

Solving for term a by substituting for b_1 and b_2 in equation 1:

$1.55= 7a + 508x0.005718913902 + 3472 \times 0.005086073194$

$1.55= 7a + 20.56405439$

$7a= -19.01405439$

$a= -2.716293485$

a= -2.7(2sf)

4.3.3 The Model

By substituting the calculated values of constants a, b_1 and b_2 in the multiple regression relation proposed in the conceptual framework the general relation:

$Y = a + b_1X_1 + b_2X_2$, where a, b_1 and b_2 are constants converts to

$Y = -2.7 + 0.0057 X_1 + 0.0051 X_2$

Or much more conventionally:

$$\mathbf{Y=0.0057\ X_1 +0.0051\ X_2 – 2.7}$$

This is the empirical Mathematical model arrived at fro this study where Y is the impact of digitization, X_1 is the MIS Metric index and X_2 is the ICT Integration Index.

Interpretation of the model

The values $b_1 = 0.0057$ and $b_2 = 0.0051$ are called partial variation coefficients.

The meaning of this model is that for every 0.0057 increase in the MIS integration index there is one unit increase in the academic slope of the institution while for every 0.0051 increase in the ICT integration index there is a unit increase in the academic slope of the institution.

4.4 Results and discussion for Objective three.

The specific objective three was to evaluate the effectiveness of the model.

The effectiveness or validity of the model of the model can be tested by first having a closer look at the data used to arrive at the model. Specifically the ICT Integration index was calculated by averaging the responses of 4 people to the same question. The average was computed to the nearest a whole number.

An excerpt of the raw responses is given here for school B

TABLE 4.10: EXCERPT OF DATA FROM QUESTIONNAIRES

SCHOOL	LEARNERS ATTENTION	LEARNERS INCREASED PERFORMANCE	PEED OF SYSTEM ACCESS	EASE OF USE OF SYSTEM	USEFULNESS OF SYSTEM	ICT ITEGRATION FACTOR
B	4	3	3	5	5	
	4	3	2	4	4	
	4	5	3	5	5	
	5	4	3	4	3	
	4	**4**	**3**	**5**	**4**	**80**

Source: Author (2017)

The researcher used the Cronbach Alpha measure of internal consistency to test the reliability of the data that was collected and thereby evaluated the reliability of the model generated.

The scale below for the index is used to test the internal consistency of the data.

Cronbach's alpha Internal consistency

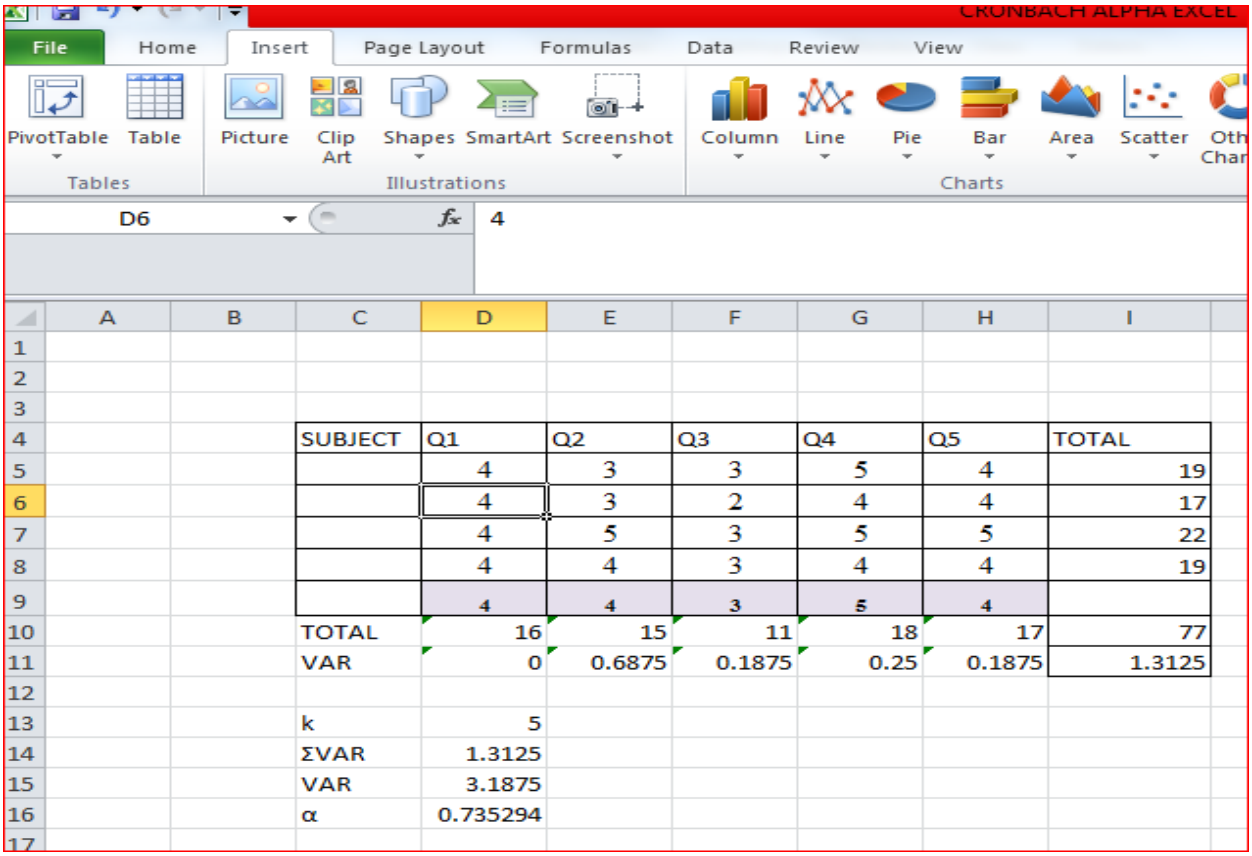
$0.9 \leq \alpha$	Excellent
$0.8 \leq \alpha < 0.9$	Good
$0.7 \leq \alpha < 0.8$	Acceptable
$0.6 \leq \alpha < 0.7$	Questionable
$0.5 \leq \alpha < 0.6$	Poor
$\alpha < 0.5$	Unacceptable

Given variable $x_1, \ldots, x_k$ and $x_0 = \sum_{j=1}^{k} x_k$ and **Cronbach's alpha** is defined to be

$$\frac{k}{k-1}\left(\frac{\sum_{i\neq j}^{k} cov(x_i, x_j)}{var(x_0)}\right) = \frac{k}{k-1}\left(1 - \frac{\sum_{j=1}^{k} var(x_j)}{var(x_0)}\right)$$

An excel worksheet was used to work out the value as shown below in screen capture below:

FIGURE 4.21:CRONBACH ALPHA EXCEL WORKSHEET CALCULATION



	A	B	C	D	E	F	G	H	I
1									
2									
3									
4			SUBJECT	Q1	Q2	Q3	Q4	Q5	TOTAL
5				4	3	3	5	4	19
6				4	3	2	4	4	17
7				4	5	3	5	5	22
8				4	4	3	4	4	19
9				4	4	3	5	4	
10			TOTAL	16	15	11	18	17	77
11			VAR	0	0.6875	0.1875	0.25	0.1875	1.3125
12									
13			k	5					
14			ΣVAR	1.3125					
15			VAR	3.1875					
16			α	0.735294					
17									

Source: Author (2017)

The cell D13 has formula COUNTA(D4:H4)

The cell D11 copied across has the formula VARP(D5:D8)

The cell D14 has the formula I11

The cell d16 has the formula (D14/(D14-1))*(1-D14/D15). This is the formula that calculates the Cronbach Alpha value for internal consistency was therefore found to be 0.735294.

This was found to be within acceptable range therefore giving some measure of internal consistency of the collected data.

Evaluating the model

To evaluate the model the following test data sampled from collected data was used would in order to find the difference between actual Y (The digitization Index) and the predicted Y.

These differences were expressed using two measures:

(i) An absolute error is the magnitude of the difference between the actual Y and the predicted Y.

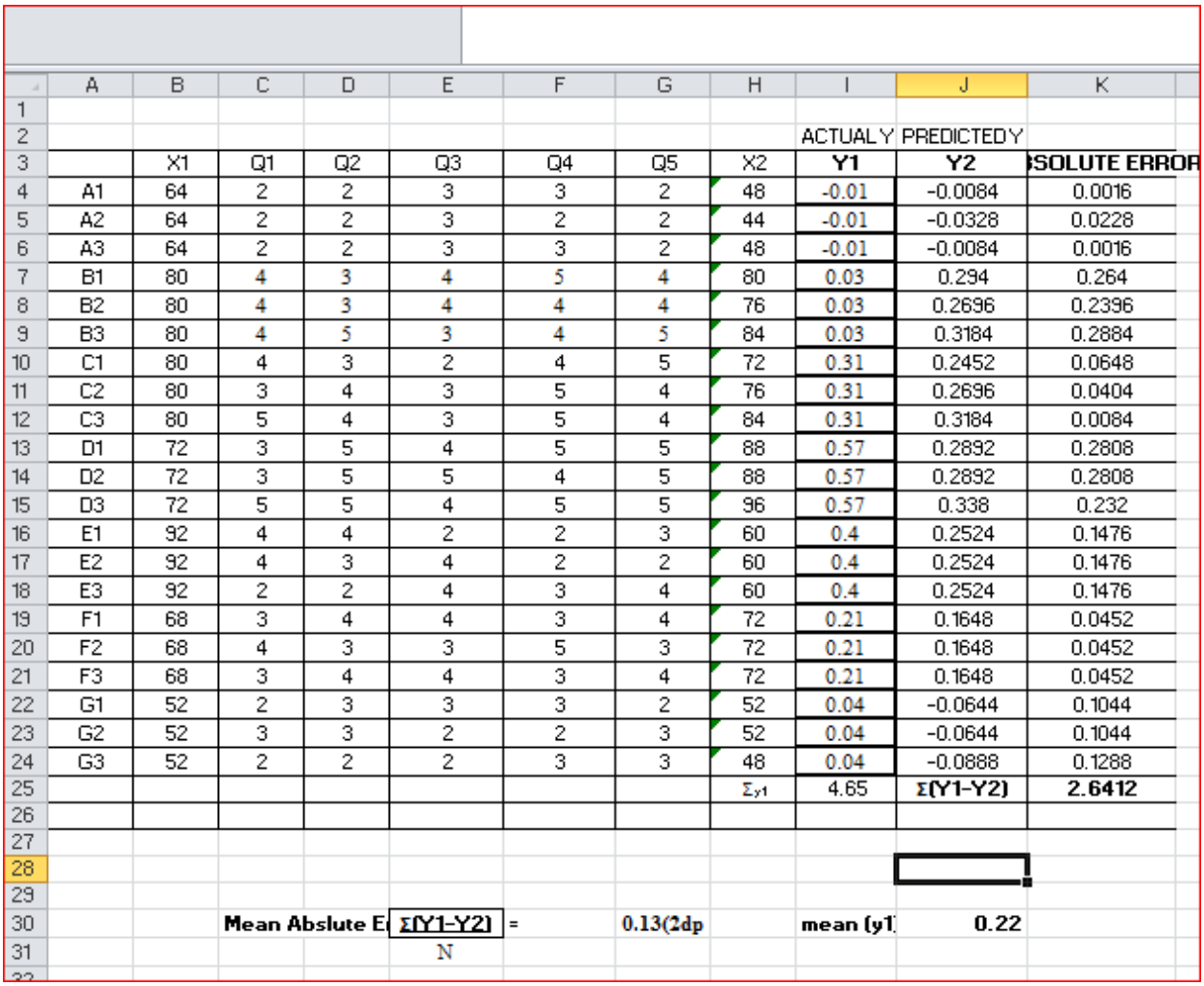
(ii) Mean Absolute Error (MAE) can be defined as sum of absolute errors divided by number of predictions. MAE measures set of predicted value to actual value i.e. how close a predicted model to actual model. In this table of results

Y = is the impact of digitization, X_1 = MIS Metric index,X_2 is the ICT Integration Index.

X_1 and X_2 were then substituted in equation to determine the predicated Y.

MS Ecel worksheet was used to work out this as shown in the screen shot below:

FIGURE 4.22 EVALUATION OF THE MODEL



	A	B	C	D	E	F	G	H	I	J	K
1											
2									ACTUAL Y	PREDICTED Y	
3		X1	Q1	Q2	Q3	Q4	Q5	X2	**Y1**	**Y2**	**SOLUTE ERROR**
4	A1	64	2	2	3	3	2	48	-0.01	-0.0084	0.0016
5	A2	64	2	2	3	2	2	44	-0.01	-0.0328	0.0228
6	A3	64	2	2	3	3	2	48	-0.01	-0.0084	0.0016
7	B1	80	4	3	4	5	4	80	0.03	0.294	0.264
8	B2	80	4	3	4	4	4	76	0.03	0.2696	0.2396
9	B3	80	4	5	3	4	5	84	0.03	0.3184	0.2884
10	C1	80	4	3	2	4	5	72	0.31	0.2452	0.0648
11	C2	80	3	4	3	5	4	76	0.31	0.2696	0.0404
12	C3	80	5	4	3	5	4	84	0.31	0.3184	0.0084
13	D1	72	3	5	4	5	5	88	0.57	0.2892	0.2808
14	D2	72	3	5	5	4	5	88	0.57	0.2892	0.2808
15	D3	72	5	5	4	5	5	96	0.57	0.338	0.232
16	E1	92	4	4	2	2	3	60	0.4	0.2524	0.1476
17	E2	92	4	3	4	2	2	60	0.4	0.2524	0.1476
18	E3	92	2	2	4	3	4	60	0.4	0.2524	0.1476
19	F1	68	3	4	4	3	4	72	0.21	0.1648	0.0452
20	F2	68	4	3	3	5	3	72	0.21	0.1648	0.0452
21	F3	68	3	4	4	3	4	72	0.21	0.1648	0.0452
22	G1	52	2	3	3	3	2	52	0.04	-0.0644	0.1044
23	G2	52	3	3	2	2	3	52	0.04	-0.0644	0.1044
24	G3	52	2	2	2	3	3	48	0.04	-0.0888	0.1288
25								Σ_{y1}	4.65	**Σ(Y1-Y2)**	**2.6412**
26											
27											
28											
29											
30			**Mean Abslute E**		**Σ(Y1-Y2)** =		**0.13(2dp**		**mean (y1**	**0.22**	
31					N						

Source: Author(2017)

An MAE of more than 0.5 is considered unacceptablefor the model predicting ability. But an MAE of lessthan 0.5 is consodored accxeptable..

HAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter draws from the summary of the findings of the study in chapter 4 to make conclusions arrived at from this study. It further recommends directions for future researches and how the findings of this study could lead to policy action.

5.2 Conclusions

In literature digitization has been found to have positive influence on the economic performance of Nations and industrial performance of companies and organizations. But the impact of digitization is not only limited to economic performances and industrial performances but as this and other studies show, to the academic performance of schools as well.

It is clear that integration of ICT in the learning process and digitizing school systems concerned with record keeping, accessing information and other processes improves service delivery of a school and ultimately the performance of the school as well.

But digitizing an institution may not be the only factors that determine good academic performance. There could be other factors such as good management, teacher and student motivation, good working environment etcetera. Digitization acts as an all-pervading enabler of all these environments that contribute to good performance of an institution.

The results of this study reveals there is a very strong positive correlation between the digitization of the institution and academic improvement (what has been quantized as slope) in this study.

These results agree with Kisirkoi(2015) case study of a school that integrated ICT in their learning programs. This study considers ICT Integration it an element in digitization of the school According to her all the 30 students observed by the researcher concentrated on their own work using computers independently. The report from the school's performance in Kenya Certificate of Secondary Education indicated that the school's mean score improved from 6.2 to 8.4 between 2007 and 2013.

Besides that digitization in literature review has been found to have impact on GDP of countries. The advances of digitization in the European continent have been able to generate substantial economic benefits according to Katz(2015). In order to estimate this impact, the econometric model developed in the context of digitization research was employed.

The model stated that 10 point increase in on digitization increases GDP per capita by 0.76%. Digitization was found to have a significant effect on economic output.
A ten point increase in the Digitization Index has approximately a 2.84% impact on GDP for the Period 2004-2011 resulting in an annualized effect of 0.40%.

The index is a weighted average of different indicators that might be endogenous to GDP like broadband and wireless penetration;

By relying on this model developed to study the economic impact of digitization, the contribution of digitization to the growth of the 27 European countries GDP was estimated. In terms of its economic impact, digitization in the Europe 27 countries generated US$ 343 billion in new GDP over the course of 2004-2011. A graph showing strong correlation between digitization and nation GDP of countries is cited in page 31 of this research report.

Digitization also has been found to have a positive correlation with industrialization. Dr Roman Friedrich et al(2011) developed an index that found out that not only is there a distinctly

wide gap between the digital haves and have-nots, but that gap appears to be growing. The leaders in digitization are moving ahead quickly, while progress among many of the laggards remains relatively slow.

In other words their model showed that the rate of growth of a company is predicated by their level of digitization.

This study set out to build a model that was to be used to assess the impact of digitization of schools. The first specific objective was to identify measures to be used to assess the impact of digitization. The measures identified were MIS metric index, which indicate the Integration of computer systems in daily management of an institution, the ICT Integration Index which indicate the degree to which ICT is used in an institution for learning purposes and the effect it has towards the learning interest and improved academic performance of the learner. This two indices were subjected to a correlational measure with the academic slope and the correlation coefficient were found to be positive and significant

5.3 Contribution to the body of knowledge

This research contribution to the body of knowledge is by expressly developing a mathematical model which can be used in measuring the impact of digitization in Educational institutions. This is a development from other measures that have been used to measure the impact of digitization in industries and in economic development of nations.

Dr. Roman Friedrich et al developed this Digitization Index and Based on this index developed 3 clusters in which various sector were found. These clusters were:, Leading, midfield and lagging.

Conspicuously missing in these clusters were Educational institutions. This model could begin to give an indication where educational sector is in terms of digitization by finding the mean of Y values for a given educational jurisdiction.

Kasirikoi (2015) case study was able to find the effect of a school was using ICT as teaching learning would have an improvement of learning environment and outcomes. This though was not expressed in quantitative terms. This study quantifies her findings.

5.4 Recommendations for Future Research

From the findings of this study digitization has direct and longtime influence on the academic performance of the school. But academic performance is not the only thing schools exist for. A good school is meant to produce an all-round student intellectually, socially and physically. Does the digitization of a school also have influence on these other aspects of learner development? Further research needs to examine this.

Secondly two aspects of digitization namely MIS and ICT integration were identified as metrics to arrive at digitization index. Could there be other aspects that could be accommodated to arrive at a more accurate digitization index. One might think of for instance digital communication, online research etcetera. It is recommended that more measures be researched on to build a much more inclusive school digitization index. Further, it is common knowledge that before Dr Fred Matiang'i was appointed Cabinet Secretary for Education in 2015 there were rampart irregularities in the conduct of National Examinations. To what effect did this influence the academic slope of the schools? This is recommended for further research.

Thirdly the sampling of this study was insufficient. Future studies should ensure sufficient samples in order to arrive at a more accurate model.

Fourthly, methodologies of this study needs to be modified and applied to other institutions other than educational. Digitization could be studied for instance in relation to health and hospitality institutions, public and even security services to examine whether it influences the performance of these institutions in delivering services to the public. Further research is recommended in this direction.

Finally with this clear indication that digitization plays a very key role in enhancing both service delivery and performance of educational institutions, the Ministry of Education need to incorporate the use of MIS and ICT in running institutions as part of their policy and not leave it open to the whims of school administrators. This is bound to have widespread benefits to our learning institutions.

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APPENDIX I: RESEARCH SCHEDULE

DATES	**EVENT**
JUNE- MID. AUGUST	PROPOSAL WRITING
AUG 28TH- 1ST SEPT	DATA COLLECTION
2nd SEPEMBER – 8TH SEPTEMBER	DATA COLLECTION
8TH SEPTEMBER	RESEARCH PROPOSAL PRESENTATION
9TH SEPTEMBER -30TH SEPTEMBER	DATA ANALYSIS
OCTOBER	CONSULTATION AND CORRECTIONS AND PROJECT REPORT WRITING
END OF OCTOBER	SUBMISSION OF FINAL DRAFT

APPENDIX II: RESEARCH BUDGET

	PARTICULARS	**AMOUNT(SH)**
1	REPORT PRINTING & BINDING	9000
2	TRANSPORT	2000
3	TELEPHONE BILLS	2000
4	INTERNET COSTS	3000
5	PERSONAL UPKEEP	2000
6	ASSISTANCE APPRECIATION	5000
7	CONTINGENCIES	2000
	TOTAL	25000

APPENDIX III: QUESTIONNAIRE A

(FOR IT PERSONNEL)

Dear respondent,

I am a student undertaking a MSc course in Information System Management at KCA university. I require information from you touching on your institution level of use of computer facilities and its impact on the learner and other stakeholders. Your responses will be treated with utmost confidentiality.

What Management Information Systems are used in your institution?_____

Please place a tick (√) for your choice responses in the spaces indicated.

How do you rate the effectiveness of the system with regard to the following?

	Very Dissatisfactory	Dissatisfactory	Average	Satisfactory	Very Satisfactory
Adequacy of ICT Infrastructure					
Systems Reliability					
Systems Speed					
Technical support					
Staff computer Literacy levels					

Thank you for your help.

APPENDIX IV: QUESTIONNAIRE B

(FOR SUBJECT TEACHERS)

Dear respondent,

I am a student undertaking a MSc course in Information System Management at KCA university.I require information from you touching on your institution level of use of computer facilities and its impact on the learner and other stakeholders. Your responses will be treated with utmost confidentiality.

What subject do you teach? ----------

Please place a tick (√) for your choice responses in the spaces indicated

1. Does you use ICT integration in teaching your subject : Yes ☐ No ☐
2. If Yes, how do you rate the effect of ICT integration on the following learner's behavior?

	Very ineffective	Ineffective	No effect	Effective	Very effective
Learners Attention					
Increased Academic performance					

3. Do you use your school's digital systems for record management e.g student marks, timetabling e.t.c

Yes ☐ No ☐

4. If Yes, how do you rate the effectiveness of the system with regard to the following attributes?

	Very dissatisfactory	Dissatisfactory	Average	Satisfactory	Very Satisfactory
Speed of systems access					
Ease of use of system					
Usefulness of system					

Thank you for your help.

APPENDIX V: FORM C

SCHOOL'S KCSE MEANSCORE COLLATION FORM

YEAR						
Mean Score						

APPENDIX VI: RESULTS ENUMERATING TABLE

SCHOOL	LEARNERS ATTENTION	LEARNERS INCREASED PERFORMANCE	PEED OF SYSTEM ACCESS	EASE OF USE OF SYSTEM	USEFULNESS OF SYSTEM	ICT ITEGRATION FACTOR
A						
	5	**4**	**4**	**4**	**5**	**44**
B						
	2	**2**	**2**	**2**	**2**	**40**
C						
	5	**4**	**3**	**3**	**4**	**76**
D						
	5	**5**	**4**	**4**	**4**	**88**
E						
	3	**2**	**2**	**3**	**2**	**60**
F						
	4	**4**	**4**	**3**	**3**	**72**
G						
	4	**3**	**2**	**2**	**2**	**52**

APPENDIX VII: SCHOOL CODING

SCHOOL	CODE
NILE RD GIRLS	A
BURUBURU GIRLS	B
OFAFA JERICHO	C
ST ANNES GIRLS	D
AQUINAS BOYS	E
HURUMA GIRLS	F
ST PATRICK HIGH	G