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ARTICLES AND RESEARCH REPORTS ON SCIENCE

ULTRASOUND BOOSTER DESIGN AND IMPLEMENTATION FOR ELECTRONIC PEST CONTROL

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Abstract
In this work, an ultrasound booster was designed to increase the effective area of coverage of an existing stand-alone ultrasound pest control device designed to deter weaver bird away from farms. It is a five-segment device, each consisting of a preamplifier, power amplifier and an ultrasonic transducer section. It receives raw ultrasound signal generated by a stand-alone ultrasound device as input, processes and transmits it via its entire segments, resulting in a 360^o horizontal spread and a bottom boost. Implementation and testing reveals that, the effective coverage area of the stand-alone ultrasound pest control device was doubled with the aid of the ultrasound booster.

Keywords: Ultrasound, Integrated circuit (IC), ultrasound booster unit, stand-alone unit, weaver birds

Introduction

Ultrasound has a character of being inaudible to human ear but can be audible to certain animals such as bat, birds, insect and rodents (Cancel, 1998, Jones & Waters, 2000, Mann, 2001). When ultrasound is generated in an environment, such animals keep away from the vicinity (Brouwer et al., 1999). This idea has been applied in pest control with some level of success (Hangiandreou, 2003). In a previous work, an ultrasound pest control device was designed to improve the effectiveness of this method (Ibrahim *et al*., 2013a; Ibrahim *et al.*, 2017). The said device was pest specific and environmental specific in the sense that, it targets only weaver birds in an endemic area of North central Nigeria (Ibrahim *et al*., 2016). Upon implementation and testing, it generates and transmit ultrasound of specific frequencies (25 kHz and 35 kHz) identified to be effective in repelling weaver birds (Ibrahim, 2015). In addition, the device when instructed is able to broadcast audio sounds of identified weaver birds predators through a mega phone in order to fortify it against habituation. However, one of the challenges encountered when the stand-alone device was deployed was in terms of its reach, as pests keep away from crops closer to the device and feeds on distant crops. The reason for this observation is because ultrasound is a short ranger (Berke, 2002), as it is easily attenuated by intervening media. As a way out of this quagmire, ultrasound booster was conceived. An ultrasound pest control booster is a device that is used to improve the signal strength of an electronically generated ultrasound for the purpose of pest control (Ibrahim, 2015). In this design concept, raw ultrasonic signal is transferred from a stand-alone ultrasound generator to a remote station, here referred to as a booster location where it is processed and transmitted within the location with a 360^o horizontal spread and a bottom boost. The aim of this work is to enhance the area of coverage of the stand-alone ultrasound pest control device through appropriate low-cost booster design.

Methodology

Circuit Design

The block schematic of the design concept is shown in Figure 1.

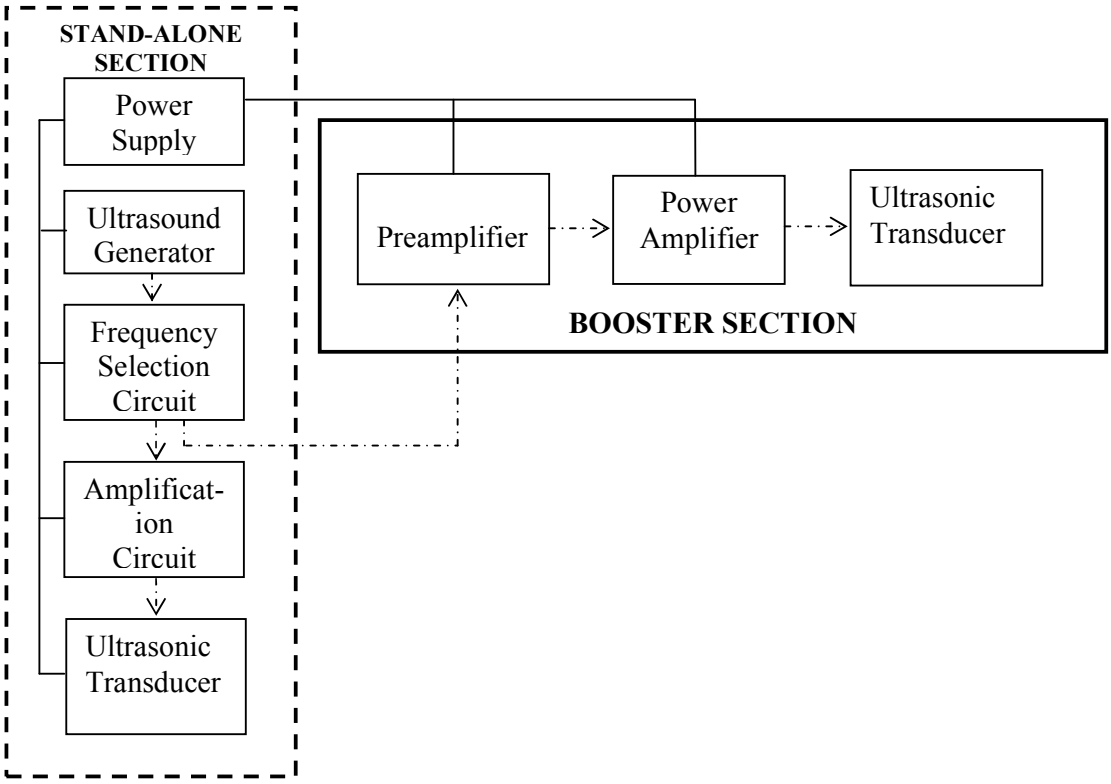

Figure 1: Block Schematic of the Ultrasound Booster Design

Figure 1 shows the two principal sections of the design namely: the stand-alone section and the booster section. The constituents of the booster section are shown by the thick solid block line on the right-hand side of Figure 1. While that of the stand-alone is shown by the thick dash line on the left-hand side of Figure 1. The stand-alone section has already been designed and implemented such that it is capable of independently generating its power and ultrasound requirements, selects a portion of the ultrasound signal for amplification and transmission in order to deter weaver birds away from the area of coverage. The booster section as evident from Figure 1 was designed to function along with the stand-alone section from where it derives its electric power and ultrasound signal. It will receive raw ultrasound signal from the stand-alone device for processing at its booster location. The ultrasonic signal relay line showing electronic signal communication between both sections is shown by the faint and directed dash lines while the power line is shown by the slime continuous lines.

The Stand-alone Section

The main thrust of this work is not on the stand-alone section, but on the booster section. However, due to the interdependence between both sections, few portions being shared shall be discussed.

The Power Supply Section: The power requirement was harnessed from the abundant solar energy of the study area using an 18 V solar panel and two 12 V batteries connected in parallel. This supply is available at the output of the tripping circuit and the booster outlets from where it is conveyed via booster cables to a booster location and from where it is regulated to meet the needs of various subsections inherent in the booster circuit. Connecting from the output of the stand-alone's tripping circuit, which is also a photo sensitive circuit (Ibrahim *et al.*, 2013a), ensures that both devices share the benefit of

tripping ON and OFF at sunrise and sunset coinciding with the period of weaver bird pests activities in farms.

The Ultrasound Generator section: the 25 and 35 kHz ultrasound to be boosted by the booster device is generated by the 25 kHz and 35 kHz oscillators of the stand-alone device. Both oscillators were designed with 555 timer IC configured in astable mode (Ibrahim *et al*., 2017).

The Frequency Selection Section: The frequency selection section of the stand-alone system does the job of selecting between the 25 kHz and 35 kHz of the 25 kHz and 35 kHz oscillators respectively in fifteen seconds interval. This is to introduce some variability into the ultrasound signal, a necessary design consideration for delaying habituation of weaver birds to ultrasound stimulus (Ibrahim *et al*, 2013b). The circuit comprises of a 555 timer in a monostable mode and a microcontroller (AT89C52) as the excitation agent. It constantly sends pulses to the timers input every fifteen seconds causing it to change state simultaneously. This operation causes a relay at the timers output to toggle, thereby connecting the 25 kHz oscillator and disconnecting the 35 kHz on one hand and disconnecting 25 kHz and reconnecting the 35 kHz oscillators on the other hand (Ibrahim, 2015). The output of the frequency selection circuit was tapped to the booster outlet from where the ultrasound signal will be tapped via a booster cables to the booster section for further processing. This connection means that the signal to be boosted is also an intermittent selection of 25 kHz and 35 kHz every fifteen seconds.

The design descriptions given so far is housed separately inside the stand-alone device and executed in a single segment. Subsequent design to be described from the next subsection is referred to as the booster design and executed in five identical segments to be housed separately in the booster box. Only one of such segments will be discussed. Connection between the stand-alone device and booster box was established by means of a cable here referred to as the booster cord.

The Booster Section

This section is the major concern of this work. It comprises of sub-sections whose designs are described below.

The Booster Preamplifier Section

The essence of a booster circuit is to magnify or strengthen an in-coming signal. Ultrasound signal has the characteristics of travelling a short-range due to ease of attenuation by the intervening medium. The need to strengthen the signal for a wider reach necessitated the introduction of preamplifier circuit to amplify the in-coming signal to an appreciable level for further processing. The IC, UR 741 was considered appropriate for the preamplifier because of its high gain. The preamplifier circuit design is shown in Figure 2.

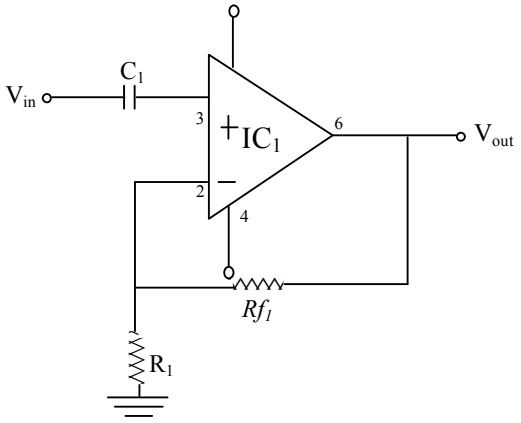

Figure 2: Preamplifier Circuit

The Voltage Gain, A_v equation of the IC is given by (Usifo, 2004);

$$A_v = \frac{V_{out}}{V_{in}} = 1 + \left[\frac{R_f}{R}\right] \quad (1)$$

where R_f is the value of the feedback resistor while R is the input resistor. Equation (1) can be modified as:

$$A_v = 1 + \left[\frac{Rf_1}{R_1}\right] \quad (2)$$

A gain of 500 was desirable for the preamplifier. Therefore, from (2), a choice of 1 K was made for R_1 and Rf_1 was calculated as 499 K. The design has a 0.1 µF capacitor (C_1) at its input, to block electrical noise that may have been generated in the stand-alone device and booster cord from entering the booster circuit. The preamplifier circuit so designed can raise the strength of the ultrasonic signal by 500. The booster cable evacuating electrical signals from the stand-alone system is a three in one cable which terminates at the input of the UR741 of the preamplifier. One of the cables transports ultrasound signal while the other two serves as the positive and negative power lines. The preamplifier and its adjoining sections constitute the booster circuit at a particular location.

The Booster Power Amplifier

The pre-amplifiers output signal serves as the input signal of the power amplifier. The preamplifier has boosted the ultrasound signal to an appreciable level to be complimented by the power amplifier. The IC, LM 386 notably applied as ultrasonic driver was adopted for the power amplifier design as shown in Figure 3.

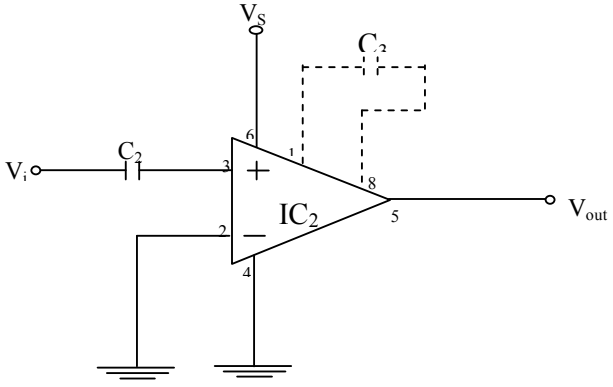

Figure 3: Power Amplifier Circuit

In order to obtain a higher gain from the IC, the circuit was modified between pin 1 and pin 8. According to National Semiconductor data sheet, to obtain the maximum gain of 200, a 10 µF capacitor is connected across pin 1 and 8. Therefore, a 10 µF capacitor (C_3) was connected across pin 1 and 8 (in dotted lines) to guarantee a gain of 200. Also, another 0.1 µF capacitor (C_2) was connected at its input to block electrical noise that may have been generated in the booster preamplifier from entering the booster circuit as shown in Figure 3. The power of the amplifier can be calculated using equation 3.

$$P = \frac{V^2}{R_L} \qquad (3)$$

where P is the power of the amplifier, V, the supply voltage and R_L is the impedance of the load. The succeeding section called the ultrasonic transducer section serves as the load on each segment and has impedance of 4 Ω. Equation (3) implies that raising the supply voltage of the power amplifier improves the power of the amplifier. But considering the fact that the device is solar powered via a 12 V battery and regulated by a 10 V regulator limits the maximum voltage required to power the amplifier to 10 V.
Equation (3) yields;

$$P = 25 \text{ W}$$

Therefore, a 25-Watt power amplifier with a gain of 200 was designed for each of the five segments of the device.

The gain in Decibel (dB) of the power amplifier is given by equation (4):

$$\text{Gain in dB} = 10\log (A_v) \qquad (4)$$

$$\text{Gain in dB} = 10\log (200) = 23.01\text{dB}$$

The total gain of the amplification section is given by the product of the preamplifier gain and the power amplifier gain. That is,

$$\text{Total Gain} = (\text{Preamplifier Gain}) \times (\text{Power Amplifier Gain}) = 100{,}000$$

This simply means that the device's amplifier has been able to raise the voltage level of the ultrasound signal transmitted to it by one hundred thousand times. With this level of amplification, the ultrasound will be propelled to penetrate deeper into the air and saturate the vicinity of broadcast to a reasonable distance. This over-all amplification gain was achieved for each of the five segments.

The Booster Ultrasonic Transducer

The role of this section is to convert the ultrasonic frequency electrical signals generated by the stand-alone device and relayed to the booster device for preamplification and amplification into an equivalent frequency sound (Britanica, 2010). The booster ultrasonic transducers also serve as the load on each of the segments. Therefore, Ultrasonic twitters with band-width extending beyond the upper frequency of 35 kHz were employed for its advantage of not only converting to sound but further transmitting or broadcasting the sound over an area. A dual diaphragm, dual outlet twitters (twin twitters) was conventionally coupled via a 220 µF capacitor, C_4. The orientation of the ultrasonic transducers ought to be such that it allows for even spread of ultrasound in the booster location. Therefore, four out of the five segments were aligned 90° horizontally to one another, and the fifth made 90° to the horizontal arrangement. By this, a 360° horizontal spread and a bottom boost is guaranteed. Figure 4 depicts this arrangement as illustrated using each segment's ultrasonic transducer.

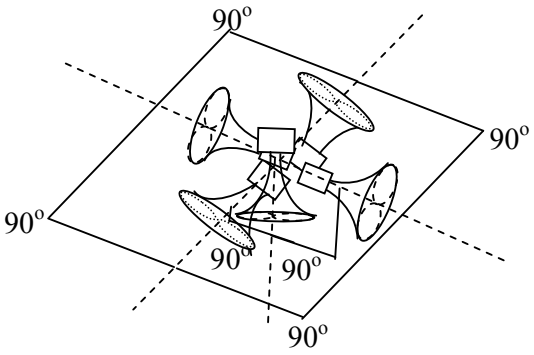

Figure 4. Orientation of each segment

Electronic Circuit Construction

Circuit Implementation

The implementation circuitry of the ultrasound booster is shown in Plate I.

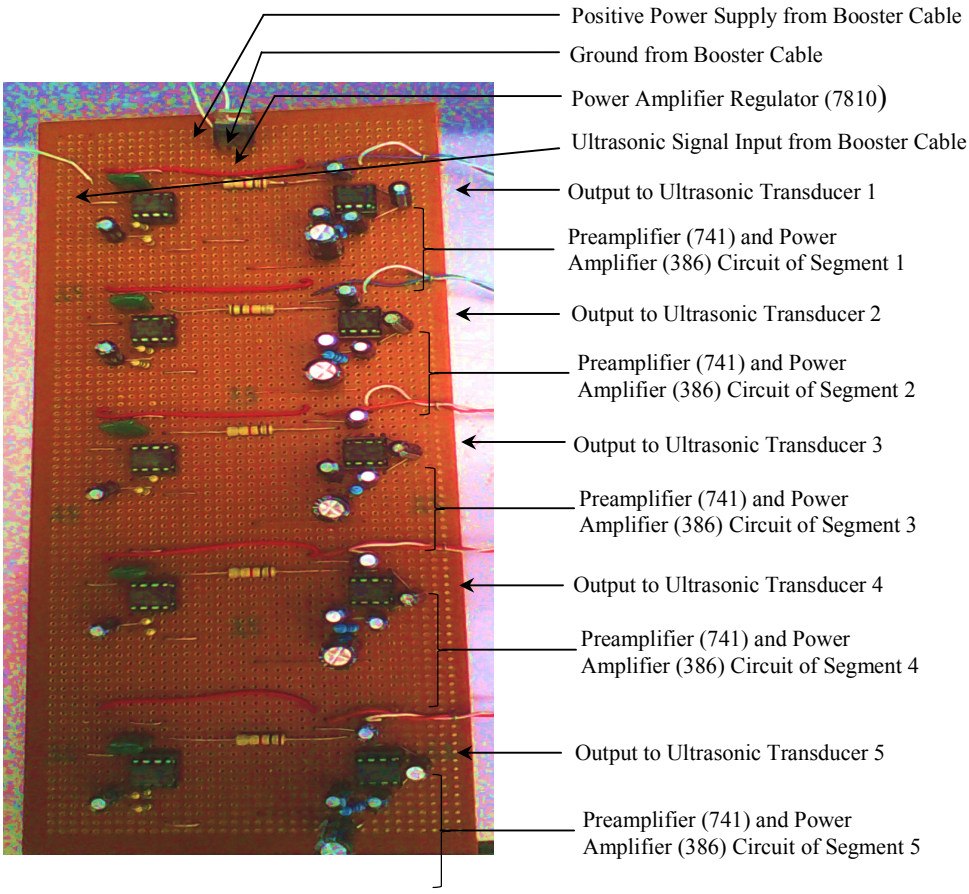

Plate I: Circuitry of the Ultrasound Booster

All components were sourced and assembled locally. The components were assembled on bread board to confirm their workability before being soldered on vero board in accordance with circuit design.

Casing Design

A wooden material was chosen to house the device because of its insulating property. Features on the casing include: Five broadcasting outlet (one on each side and one at the bottom); booster inlet and four clips at the base for fastening to the stand. A dimension of 33 cm x 29 cm x 16 cm was chosen to adequately house the electronic panel and ultrasonic twitters The casing, together with its circuitry, is also referred to as the booster box. Photograph of the casing interior of the booster box is shown in Plates II.

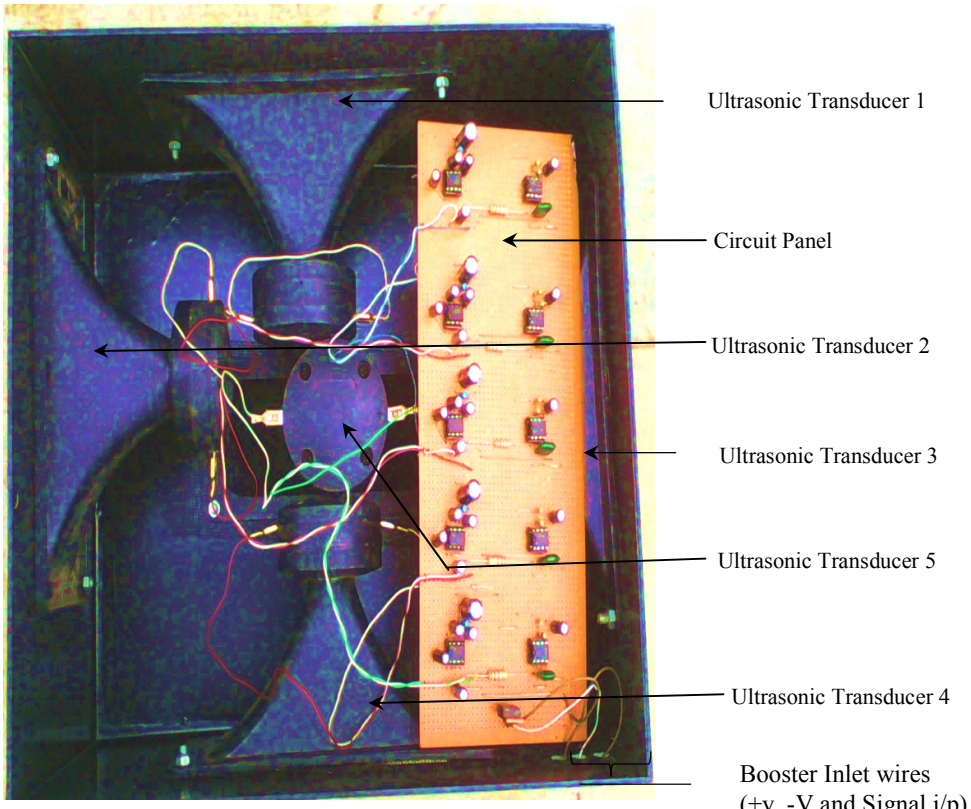

Plate II: Circuitry and Casing Interior of a Booster Box

Construction of Adjustable Support

An adjustable support of 1.2 meters to 5.5 meters high with a detachable horizontal platform of dimensions 35 cm x 35 cm on top of which the booster box will sit was implemented. A little portion of the platform having dimension 13 cm x 6 cm was opened to provide space for the bottom broadcasting outlet. These stand help to raise the device to the same height with the crops. Millet, sorghum and rice, for example, have their pest target points located at their topmost part. Therefore, the adjustable stands will help in achieving this leveling which allows for better interaction between the signal and the pest in different farm types and from trees housing them. Plate III shows the picture of the adjustable stands, horizontal platform and a booster box which constitute a booster unit.

Plate III: A Booster Unit

Results and Discussion

The outcome of this design concept consists of the booster unit working in synergy with the stand-alone unit as shown in Plate IV.

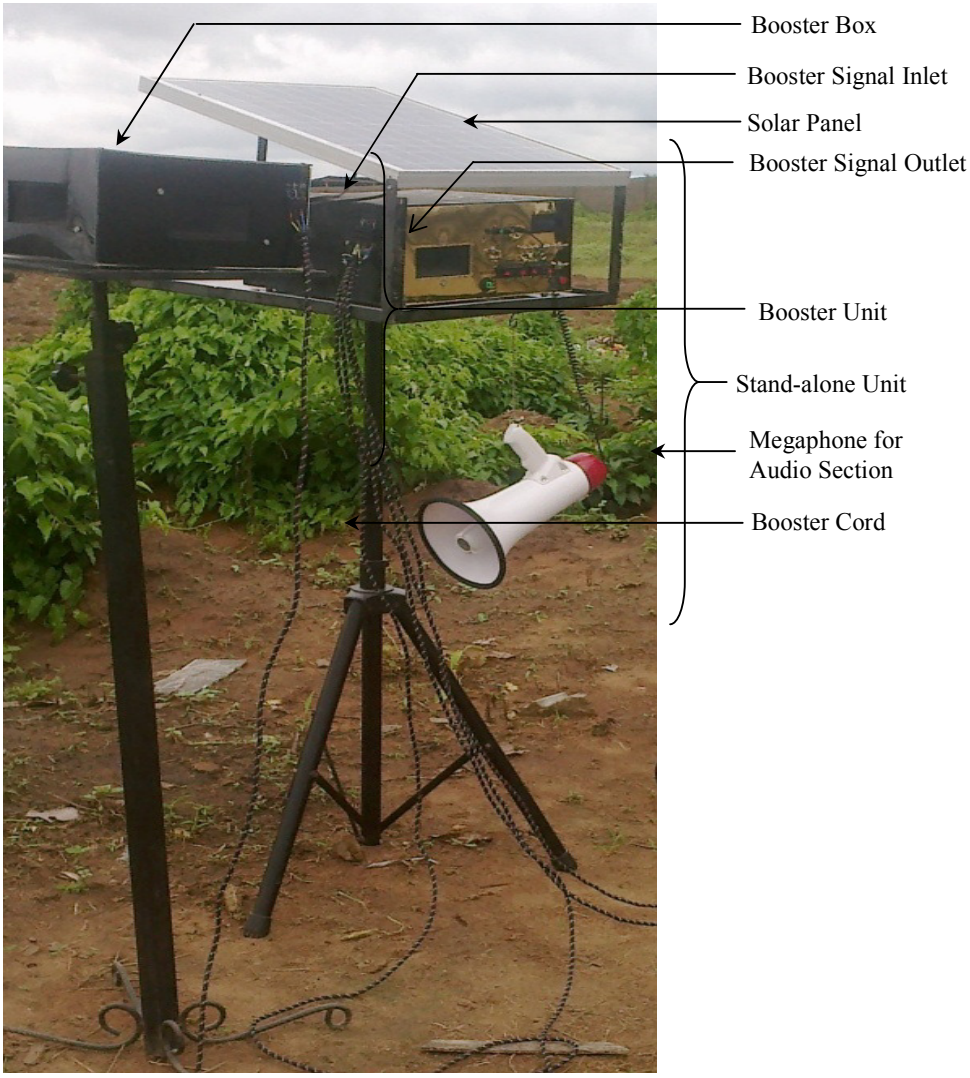

Plate IV: Set-up of the Booster mode of operation accomplished with the Stand-alone Device and a Booster

In this ultrasound booster mode, the stand-alone device functions as the ultrasound generator and power house of the entire system. With the booster switch on the stand-alone device activated, the booster mode is enabled and the preamplifier, amplifier and ultrasonic transducers of the booster device automatically starts operation in addition to those of the stand-alone device.

The following steps are followed while on the farm in order to operate the ultrasound booster system effectively:

(i) The stands of the stand-alone device and the booster box are coupled by adjusting the legs and attaching the horizontal platforms as shown in Plates IV;

(ii) The stand-alone device and the booster box are placed on their respective platforms and fastened;

(iii) The solar panel is placed above the stand-alone device by screwing the front to the platforms support and the rear is hooked to the stopper as shown in Plate IV. In

this position the panel is at the required solar angle of 10^{o} to the horizontal. Solar angle is approximately equal to the latitude of the location;

(iv) The stand-alone unit is rotated such that the solar panel faces south. This provides the required direction for a direct exposure to the sun's rays;

(v) The solar panel's cable is plugged into the stand-alone device's power socket and the charging buttom is pressed to commence charging the battery;

(vi) The booster cord is plugged into the booster outlet on the stand-alone device and the other end into the booster inlet of the booster box. This will make available the needed power supply to boost the ultrasonic frequency signal to be supplied along the same cord at the booster location;

(vii) The booster box and stand are taken to desired booster location;

(viii) The stand is adjusted to about the same height as the crop. This levelling is necessary for better interaction with target part of the crops;

(ix) Pressing the power button of the stand-alone device and activating the booster switch makes the supply voltage (V_{CC}) available to the tripping section. If it is daytime, the section automatically clicks and feeds the supply line to power the other sections. But at evenings, this section trips OFF, disconnecting the other sections. When tripped ON, the timing section sets the frequency with which each of the oscillators will operate. The 25 and 35 kHz frequency signals generated by the oscillators are intermittently selected at 15 seconds interval by the frequency selection section and passed to the booster outlet and from where the signal is transported through the booster cords to the booster box for amplification and broadcasting throughout all its segments in its booster location;

(x) When habituation is observed to be setting in after about four weeks of operation, the audio section is activated by hanging the megaphone on its hanger located below the standalone horizontal platform and the input jack is slotted into the device's audio outlet as shown in Plate IV. The predator cry section (audio section) is activated by selecting the desired predator option to release the recorded predator sound for broadcasting by the megaphone.

Both the stand-alone device and the booster box simultaneously transmit ultrasound in five segments. A performance evaluation carried out on the stand-alone device using an ultrasound detector (Seriki, 2014) and by field inspection (Ibrahim *et al.*, 2017b) reveals that high intensity ultrasound was detected to a distance of thirty five meters (35 m), constituting an area of three thousand, eight hundred and fifty square meters (3850 m^2). Since the design parameters of the entire booster circuit was patterned after that of the signal propelling portion of the stand-alone design, it can be said that a similar distance and area of ultrasound coverage by the standalone device have been replicated for the booster box. Therefore, the booster system design employed (stand-alone working in synergy with the booster box) has doubled the ultrasound coverage of the stand-alone design. This advantage was reached at a reduced cost since the ultrasound generation section, solar panel, battery, charge controller, tripping section, frequency selection section, audio section and other peripherals of the stand-alone device were eliminated from the booster design.

Conclusion

The five-segment concept and the nature of transducer orientation used keeps the entire booster location and the stand-alone location saturated with ultrasound while in operation. With more area of land covered by ultrasound, the pest deterrent property of ultrasound is extended to more crops as they are brought under its protective cover, resulting in the availability of more food and the rapid attainance of food sufficiency. The design economics of having an ultrasound booster rather than replication of stand-alone device gives credence to the low-cost design concept. The focus of future research is on further enhancing the ultrasound coverage area by increasing the number of booster units, better booster configurations and modification of the stand-alone design to match-up these future design expansions.

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INSTRUMENTAL NEUTRON ACTIVATION OF TRACE ELEMENTS IN SOILS AND SEDIMENTS AROUND THE KADUNA REFINERY AND DATA EVALUATION USING CLUSTER TECHNIQUES

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Abstract
A large number of experimental objects is usually associated with large data. Meaningful interpretation of such data set is very crucial to ascertain the pattern of their existence within the host matrices. Achieving this requires some sort of groupings in order of hierarchy. Instrumental Neutron Activation Analysis (INAA) was used to determine the abundance and distribution of elemental pollutants in soils and sediments around Kaduna Refinery. Results of the activation analysis revealed that Twenty Five (25) elements including: Mg, Al, Ti, V, Mn, Na, K, As, La, Sc, Cr, Fe, Co, Zn, Rb, Sb, Cs, Ba, Eu, Yb, Lu, Hf, Ta, Th, and Dy were detected. The data set acquired from this work was subjected to cluster analysis using the method of SINGLE LINKAGE. Using the computer-aided statistical package, SAS, dendograms were generated. The resulting dendograms revealed some useful patterns which were used to segregate the different soil environments (upland soil, fadama soil, rocky soil, and sediments) in the study area. A repeat of clustering procedures without the elemental concentrations of the sediments led to regrouping of old clusters, giving rise to clearer picture of the groupings. The samples were clearly regrouped based on the soil environments (upland and fadama soils).

Keywords: Cluster technique, Elemental pollutants, Soil environment, INAA

Introduction

Cluster technique is a statistical tool used to analyze a large data suite (data set). The program is used to observe the clustering pattern of samples based on the concentrations of elemental pollutants measured. Cluster analysis becomes very useful when the data set is very large such that it becomes difficult to recognize trend or pattern (Everitt, 1979). Useful algorithms have been proposed to overcome this dilemma (Dubes & Jain, 1979). To achieve the desired clustering, the very large data suites are reduced to points in the hyperspace based on similarities and differences in the concentrations of different elements (Oladipo, 1987). Data evaluation begins first by considering each observation in itself as the smallest cluster. This is then followed by fusing of two nearest neighbours to replace the old clusters (agglomerative clustering). The procedure continues this way until only one cluster is left at the last stage (Milligan & Cooper, 1985; Ibàñez et al., 2013). The clustering pattern which is based on hierarchy completes (n – 1) fusion steps, resulting to a tree of clusters called dendogram (Jain & Dubes, 1988). Van der Sloot, (1980) classified coal by trace element analysis using INAA, cluster analysis, and leaching of precipitator ash. Hopke *et al.*, (1987) also interpreted multielemental INAA data using pattern recognition methods. Ewa *et al.*, (1992) used cluster technique to study the elemental concentration of cored Nigerian river sediment, and using data evaluation of trace elements, Ewa, (2004) was able to segregate the Nigerian coal.

The results of cluster analysis can be presented in form of dendograms which are graphical representations that display the groups formed by clustering of observations and their similarity levels. In the Ward method (Ward, 1963), points representing individual samples are tied together to form a cluster. A plot is made of the fusion of successive samples

against fusion or similarity coefficients as the membership of a group or heterogeneity increases (Oladipo, 1987). Individual samples also exist, and are referred to as outliers. Outliers sometimes make it difficult in distinguishing clusters in residual data. The way out of this problem according to Oladipo, (1987) is to rid the data of outliers and repeat the clustering procedures. Meaningful explanations can be made of outliers, hence, they are not out-rightly discarded (Oladipo, 1987).

Methodology

The Study Area

Plate I. The study area indicating sampled locations

Kaduna Refining and Petrochemical Company (KRPC) and its environs which is partly hosted by Rido village lies in the southern area of Kaduna city, occupying an area between latitude 10°, 24' 22.32" - 10° 25' 18.8" N and longitude 7°, 29' 9.6" - 7° 29' 55.2" E**.** The major occupation of the inhabitants of the host communities is farming. In addition to this, petroleum industry-related activities take place on daily basis in the area.

Sample Collection

Fifteen (15) soil samples within the top 0 – 20 cm were collected from farmlands around the Refinery Complex (including Rido village) using an Auger and labeled S01, S02,…, S15. Similarly, five (5) sediment samples were collected from a river and a stream that traverse the study area and labeled SD1, SD2, .., SD5. The samples were thereafter dried in an oven at 100℃ for 48 hours.

Sample preparation, irradiation, and counting

The sample preparation for INAA determination of elemental pollutants commenced in the NAA preparation room with the measurement of a quantity of finely crushed samples to be irradiated using the four-digit weighing balance (Metler AE 166, Delta range).

The INAA was carried out using a 31 kW miniature neutron source reactor with a neutron flux of 5 x 10^{11} n/cm^2/s. Crushed samples of soils and sediments were weighed into pre-treated polyethylene bags and heat - sealed in 7 cm^3 rabbit capsules which were packaged into bigger vials in readiness for irradiation. The vials containing the rabbit capsules were sent to the reactor irradiation sites using the pneumatic transfer system. The Nigeria Research Reactor – 1 (NIRR – 1) at the Centre for Energy Research and Training (CERT), Ahmadu Bello University, Zaria, contains four irradiation channels in which short and long

irradiations were done. This was followed by measurements of radioactivity of induced radionuclides in a process known as counting.

The concentration c_x of each element in the sample is expressed as:

$$c_x = c_s \frac{w_s}{w_x} * \frac{A_x}{A_s} \qquad 1.1$$

where c_x and c_s are the concentrations of sample and standard respectively.

Table 1: Typical irradiation and counting schemes (Jonah *et al.*, 2006)

Neutron flux /irradiation channel	Procedure	T_{irr}	T_d	T_m	Activation products
$1x10^{11}n/cm^2$ s /outer irradiation channels (B4, A2)	S1	2 min	2-15 min	10 min	^{28}Al, ^{27}Mg, ^{38}Cl, ^{49}Ca, ^{66}Cu, ^{51}Ti, ^{52}V, ^{116m}In
	S2	2 min	3-4 h	10 min	^{24}Na, ^{42}K, ^{165}Dy, ^{56}Mn, ^{152m}Eu
$5\times10^{11}n/cm^2s$ /inner irradiation Channels (B1, B2, B3, and A1)	L1	6 h	4-5 d	30 min	^{24}Na, ^{42}K, ^{76}As, ^{82}Br, ^{140}La, ^{153}Sm, ^{198}Au, $^{139}Np(U)$, ^{72}Ga, $^{122}Sb^{46}Sc$, ^{141}Ce, ^{60}Co, ^{51}Cr, ^{134}Cs, ^{152}Eu, ^{177}Lu, ^{131}Ba, ^{86}Rb, ^{182}Ta, ^{160}Tb, ^{175}Yb, $^{233}Pa(Th)$, ^{65}Zn, ^{59}Fe, ^{181}Hf.
	L2	6 h	10-15 d	60 min	

Table 1 gives the details of both the irradiation and counting regimes used. Finally, the analysis software, WINSPAN was used for quantitative spectrum analysis.

A very sensitive (high-resolution) gamma-ray spectrometer was used to register the delayed gamma, and the computer-coupled multichannel analyzer sorted the delayed gamma according to their energies. Finally, the gamma-ray acquisition system used the computer software (MAESTRO – 32) to measure the associated activity.

Cluster Technique

The method of SINGLE LINKAGE (SAS, 1995) and the Squared Euclidian distance were chosen to determine the similarities in the clustering as a measure of minimum distance between clusters. The technique (METHOD = SINGLE LINKAGE) was employed according to Ewa, (2004) as introduced by Florek *et al.*, (1951) and Sneath, (1957) to observe the relationship between the concentration of each element in one sample and another.

Results and Discussion

INAA

Results of instrumental neutron activation analysis showed that Twenty Five (25) elements (Mg, Al, Ti, V, Mn, Na, K, As, La, Sc, Cr, Fe, Co, Zn, Rb, Sb, Cs, Ba, Eu, Yb, Lu, Hf, Ta, Th, and Dy) were detected. These elements which cut across major, minor and trace elements were detected in varying concentrations in both soils and sediments.

Cluster technique

The results of data evaluation yielded two dendograms as presented in Figures 1 and 2. The dendograms resulting shows that there are four clusters (1, 2, 3 and 4).

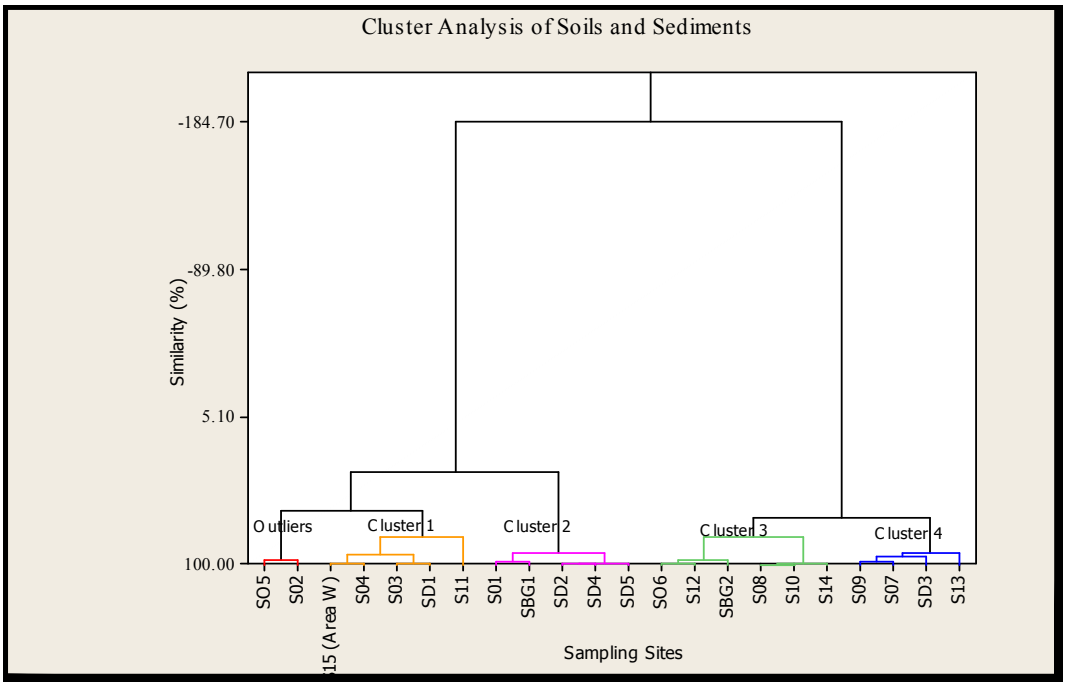

Figure 1: Cluster dendogram for soils and sediments

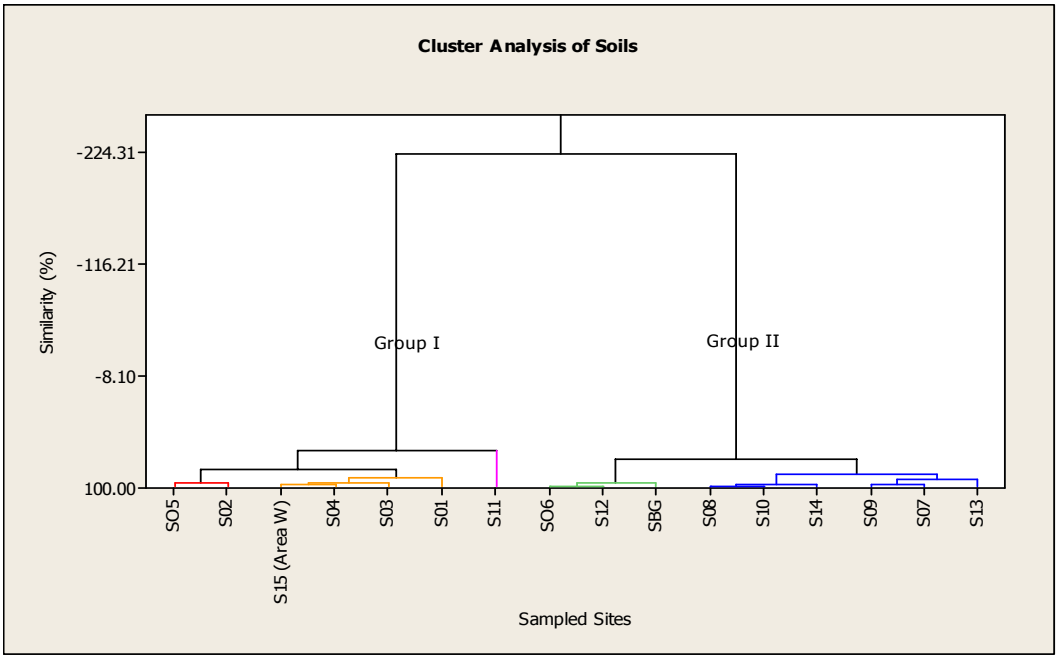

Figure 2: Cluster dendogram for soils only

Before one can start the grouping of samples, a measure of similarity must be defined (Ibàñez et al., 2013). Each sample must be compared with every other sample and those

that are very "similar" in chemical composition will then be subsequently found in the same cluster, while "dissimilar" ones will be found in different clusters (Ibàñez et al., 2013).

The similarity between two elements can be measured in many different ways but in this work, "distance" has been chosen. In most cases, the "similarity" between the samples is rather hard to define, while the "distance" that is inversely proportional to it is much easier to visualize and handle.

Five samples (S15, S04, S03, SD1, and S11) clustered together to form a group referred to as cluster 1, with the clustered samples having a similarity level of 82.19 %, five other samples (S01, SBG1, SD2, SD4, and SD5) formed cluster 2 at 92.09 % similarity level, six samples (S06, S12, SBG2, S08, S10, and S14) formed cluster 3 with member samples having a similarity level of 81.87 %, while four samples (S09, S07, SD3, and S13) formed cluster 4 at 92.34 % similarity level. The deviating elements responsible for the separation of the samples into clusters include Ta, Lu, Eu, Sb, Cs, and Yb, having grand centroids of 1.6, 5.1, 5.1, 1.5, 5.4, and 9.4 respectively. The lower the value of the grand centroid, the better the discriminating power between the samples. Cluster 1 is made up of members from different environments (fadama soil, sediments, sludge, and upland soils); cluster 2, though mixed consists mainly of sediment samples; cluster 3 is made up, mainly of upland soils while cluster 4 is also mainly upland but rocky soils with a member from the sediments.

When the elemental concentrations of the sediments were removed from the data set, the resulting dendogram is as given in Figure 2. As a result of this process, the clusters again regrouped to form two main clusters or groups (group I and group II), giving rise to a clearer picture of groupings. The samples were clearly divided along the lines of the soil environments. Cluster group I which was made up of soil samples of fadama origin (S01, S02, S03, S04, S05, S11, and S15) clustered at a similarity level of 65.75% and consists mostly of samples collected from farmlands around Rido village used mainly for cultivation of rice. The sample tagged S15 (Area W) was taken from the refinery sludge pit which has water environment similar to the fadama soils. Cluster group II (which comprised of samples S06, S07, S08, S09, S10, S12, S13, and SBG that clustered at 73.66 % similarity level) on the other hand consists of upland soils from the farmlands bordering the northern part of the refinery complex and part of Rido village that occupies higher elevations than the fadama environments. These upland regions are characterized by hard-pan concretions in both the dry and rainy seasons where metals are highly immobile.

The deviation of the elements resulting into clusters and the interstitial nature of the membership of some clusters (especially Figure 1) may be attributed to the complex nature of some elements that enable them to bind with many other elements and react differently. The reaction of a particular element depends on its solubility, physico-chemical properties of water, water content of soil, and other physical/chemical properties which make predictions of their existence in a particular environment rather difficult. This probably explains the reason for lack of systematic trend in the membership of the clusters.

Conclusion

Twenty five (25) elements (major, minor, and trace) were detected in soils and sediments around the refinery complex. Subjecting the data to clustering procedures revealed that the behaviour of elements in a water environment differs from that in dry soil. The cluster technique has therefore proved to be a veritable tool in handling large data suites based on similarities or dissimilarities of members of a set of experimental objects. In the final analysis, the soil samples were segregated into two large groups/clusters with memberships belonging to either fadama soil or upland soil.

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EVALUATING TRAP PARAMETERS OF THERMOLUMINESCENCE GLOW-CURVES CONSIDERING TEMPERATURE DEPENDENT FREQUENCY FACTOR

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Abstract
First and general order thermoluminescence glow curves were simulated in a MATLAB environment. The simulated curves considered the case when the pre-exponential or frequency factor is temperature dependent for kinetic orders ranging from 1.0 to 2.0. For each order the temperature dependent index was varied from -1 to +2. Simple and practicable analytic expressions were developed for evaluating the activation energy, order of kinetics and the temperature index of the frequency factor. The activation energies obtained using method developed in this report were very accurate and closer to the input values when compared to well-known peak shape and variable heating rate methods.

Keywords: kinetic parameters; glow curves; frequency factor; thermo stimulated luminescence; dosimetry

Introduction

Thermo-stimulated luminescence (TSL) is a luminescence phenomenon peculiar to insulators and semi-conductors (Bos, 2007). The luminescence is observed when solid (phosphor) which previously had absorbed energy from radiation is heated at a constant rate (β). In principle, the exposure to radiation liberates electrons and holes which are eventually trapped within the forbidden band gap between the valence and conduction band of the crystal lattice of the phosphor. When the phosphor is heated the electron and holes recombine to produce light quanta. The intensity of the light produced during the heating process is proportional to the radiation dosage. Consequently, TSL has been widely used among others: to record radiation history of archaeological materials, in radiation dosimetry, in the study of crystal defects (Chen & Mckeever, 1997), and also in the detection of phase transition (Townsend, Maghrabi, & Yang, 2007).

The plot of the TSL light output as a function of temperature gives the glow curve. The size and position of the glow curve provide information about the trapping parameters. These parameters are characteristic of the electron traps created by the radiation. The mechanism of trapping and recombination of the resultant electrons and holes are discussed in detail by Chen and Mckeever (1997). Determination of the trapping (kinetic) parameters is crucial in many application of TSL. The major parameters which are mostly evaluated are: the activation energy (trap depth) 'E', order of kinetics 'b', frequency factor 's' and initial concentration of trapped electrons n_0. Owing to their importance, evaluation of these parameters has become an active area of research. Consequently, many models, empirical expressions and algorithm have been developed for obtaining them for the past six decades. Many of these methods have been discussed extensively by Furetta (2003). Notable among them are the initial rise (IR), variable heating rate (VHR), peak shape (PS) method and recently the three points method (Rasheedy, 2005) and two point method (Ogundare, & Chithambo, 2006a). All of these methods and expressions are mostly applicable to single peak or highly isolated glow curves and were developed on the assumption that frequency factor 's' remain a constant throughout the entire TL process. However 's' does depend on temperature according to the equation (Keating, 1961): $s(T) = sT^{\alpha}$ where $-2 \leq \alpha \leq 2$.

Here 'a' is the temperature index of the frequency factor. Ignoring this dependence, results in significant errors in evaluated kinetic parameters (Yazici, & Ozturk, 1998) depending on the value of 'a'. (Aramu, Brovetto, & Rucci, 1966) showed that when): $s(T) = sT^a$, the 'E' evaluated using the IR method and by extension the PS and VHR methods (Chen, & Mckeever, 1997) are overestimated by a factor of 'akT_m', with k being the Boltzmann constant and T_m the peak temperature of the TL glow curve. They have thus suggested that where the value of 'a' is known, the error can be corrected. Other authors (most of which have been reviewed by Furetta (2003) have developed expressions for the evaluation of 'E' as a function of 'a', but fail to suggest a reliable method of obtaining the temperature index. A simple and practical way of obtaining the index is thus crucial to accurate determination of E and other kinetic parameters. Lately, Yazici (1998) developed a method based on two heating rates and peak parameters for evaluating the index. the result of the method when applied to first order kinetics was very successful but could not be independently verified for other orders of kinetics as it requires some predetermined constants which may not necessarily be a constant throughout the entire TL process.

In this work we propose a simple and reliable method for obtaining the temperature index 'a', 'E' and 'b' for the case when: $(T) = sT^a$. The evaluated temperature index could be used with existing methods for the correction of E in expressions where the temperature dependency of s is ignored. It is also expected that 'E' evaluated by method suggested in this article would be void of errors when compared to those obtained using the well known PS and VHR methods.

Glow curve simulation

The equation governing the TL processes have been given for first and general order by Randall and Wilkins (1945); and May and Partridge)1964 respectively as:

$$I(t) = -\frac{dn}{dt} = ns\ exp(-\frac{E}{kT}) \quad (1)$$

$$I(t) = -\frac{dn}{dt} = n^b s' \exp\left(-\frac{E}{kT}\right) \quad (2)$$

Where, k is the Boltzmann constant (eV/K), t is time (s), T is temperature in (K), s the frequency factor (s^{-1}) and s' the pre-exponential factor (Rasheedy (1993); Ogundare & Chittambo (2006). The solutions to equations (1) and (2) assuming a linear heating rate (β) such that

$$T = T_0 + \beta t \quad (3)$$

where T_0, is the initial temperature of the phosphor prior heating and T the temperature at a later time are:

$$I(T) = n_0 s \exp\left(-\frac{E}{kT}\right) \exp\left[-{}^{s}/_{\beta} \int_{T_0}^{T} \exp\left(-\frac{E}{kT}\right) dT\right] \quad (4)$$

$$I(T) = n_0^b s' \exp\left(-\frac{E}{kT}\right) \left[1 + \frac{s'(b-1)n_0^{b-1}}{\beta} \int_{T_0}^{T} \exp\left(-\frac{E}{kT}\right)\right]^{-\frac{b}{b-1}} \quad (5)$$

Considering the case $s = s(a,T) = sT^a$ and consequently $s' = s'(a,T) = s'T^a$ equations (1), (2), (4) and (5) becomes:

$$I(T) = -\frac{dn}{dT} = \frac{nsT^a}{\beta}\ exp(-\frac{E}{kT}) \quad (6)$$

$$I(T) = -\frac{dn}{dT} = \frac{n^b s' T^a}{\beta} \exp\left(-\frac{E}{kT}\right) \quad (7)$$

$$I(T) = n_0 s T^a \exp\left(-\frac{E}{kT}\right) \exp\left[-\frac{s}{\beta}\varphi\right] \quad (8)$$

$$I(T) = n_0^b s' \mathrm{T}^a \exp\left(-\frac{E}{kT}\right)\left[1 + \frac{s'(b-1)n_0^{b-1}}{\beta}\varphi\right]^{-\frac{b}{b-1}} \quad (9)$$

Where φ in equation (8) and (9) is the integral:

$$\varphi = \int_{T_0}^{T} T^a \exp\left(-E/_{kT}\right) dT \quad (10)$$

φ is a complex integral and can be solved using incomplete gamma function [8].

$$\varphi = \int_{T_0}^{T} T^a \exp\left(-E/_{kT}\right) dT = \left[\frac{E}{k}\right]^{a+1} [\Gamma(-1-a,x) - \Gamma(-1-a,x_0)] \quad (11)$$

Where, $x = \frac{E}{kT}$, and $x_0 = \frac{E}{kT_0}$

Assuming as $\rightarrow 0$, $T_0 \rightarrow 0$ and $\Gamma(-1-a,x_0) \approx 0$ thus

For positive and negative integer values of a except $a = -2$

$$\varphi = \left[\frac{E}{k}\right]^{a+1} \Gamma(-1-a,x) = \left[\frac{E}{k}\right]^{a+1} \left[\frac{\mathrm{E}_i(x)}{x^{a+1}}\right] \quad (12)$$

$$\mathrm{E}_i(\mathrm{x}) = \frac{1}{x}\exp(-\mathrm{x})[1 - \mathrm{x}^{-1} + 2\mathrm{x}^{-2}] \quad (13)$$

Higher order of x have been ignored in the above equation (13) since the quantity x is always very small in the range of occurrence of TL peaks [15]. Consequently,

$$\varphi = \frac{kT^{a+2}}{E}\exp\left(-\frac{E}{kT}\right)\left[1 - \frac{kT}{E} + 2\left(\frac{kT}{E}\right)^2\right] \quad (14)$$

Equations (8) and (9) can now be written as:

$$I(T) = n_0 s T^a \exp\left(-\frac{E}{kT}\right)\exp\left(-\frac{skT^{a+2}}{\beta E}\exp\left(-\frac{E}{kT}\right)\left[1 - \frac{kT}{E} + 2\left(\frac{kT}{E}\right)^2\right]\right) \quad (15)$$

$$I(T) = n_0^b s' \mathrm{T}^a \exp\left(-\frac{E}{kT}\right)\left[1 + \frac{s'(b-1)n_0^{b-1}kT^{a+2}}{\beta E}\exp\left(-\frac{E}{kT}\right)\left[1 - \frac{kT}{E} + 2\left(\frac{kT}{E}\right)^2\right]\right]^{-\frac{b}{b-1}} \quad (16)$$

Equations (15) and (16) were used to generate computerize first and general order glow curves for the parameters: E= 0.9; a=-1, 0, 1, and 2, $\beta = 1\ K/s$, s =2.00 x 10^{13} ; $n = 1$,and kinetic order b varied from 1 to 2 in steps of 0.1.

Evaluation of kinetic parameters

Order of kinetic

To evaluate the order of kinetic, we consider equation (7) on two glow curves for β_1 and β_2 respectively at a temperature T:

$$I_{\beta 1}(T) = \frac{n_{\beta_1}^b s' T^a \exp\left(-\frac{E}{kT}\right)}{\beta_1} \quad (17)$$

$$I_{\beta 2}(T) = \frac{n_{\beta_2}^b s' T^a \left(-\frac{E}{kT}\right)}{\beta 2} \quad (18)$$

Where $n_{\beta i}(T)$ is the area under the glow curve from temperature T to the end of the glow curve. Dividing equation (17) by (18) and rearranging,

$$b = \frac{\ln\left[\frac{\beta_2 I_{\beta_1}(T)}{\beta_2 I_{\beta_2}(T)}\right]}{\ln\left[\frac{n_{\beta_1}(T)}{n_{\beta_2}(T)}\right]} \quad (19)$$

Determination of 'E' and 'a'

Evaluation of the activation energy and temperature dependent index involves the consideration of one of the glow curves used in the evaluation of b. Three points on the glow curve at a heating rate β is given according to equation (7) as:

$$I_1(T_1) = \frac{n_0^b s' T_1^a}{\beta} \exp\left(-\frac{E}{kT_1}\right) \quad (20)$$

$$I_2(T_2) = \frac{n_0^b s' T_2^a}{\beta} \exp\left(-\frac{E}{kT_2}\right) \quad (21)$$

$$I_3(T_3) = \frac{n_0^b s' T_3^a}{\beta} \exp\left(-\frac{E}{kT_3}\right) \quad (22)$$

Dividing equations (20) by (21) and (23) separately and rearranging we obtain two equations that can be solved simultaneously:

$$ax_{12} + Ey_{12} = z_{12} \quad (23)$$

$$ax_{13} + Ey_{13} = z_{13} \quad (24)$$

Where $x_{ij} = ln\left(\frac{T_i}{T_j}\right)$; $y_{ij} = \frac{1}{k}\left(\frac{1}{T_j} - \frac{1}{T_i}\right)$; and $z_{ij} = ln\left[\left(\frac{I_i}{I_j}\right)\left(\frac{n_j}{n_i}\right)^b\right]$.

If b obtained in equation (19) is used then equations (23) and (24) can be used to evaluate the activation energy E and the temperature index (a) of the frequency factor.

Results and Discussion

A total of 44 glow curves were theoretically generated in MATLAB (MATLAB R2007a, The MathWorks Inc., 3 Apple Hill Drive, Natick, MA 01760) environment using equations (15) and (16) for the various values of 'a' and 'b' considered. Fig.1 is a sample of one of the glow curves for a=-1 and b=1.4. Generally, the behavior of the glow curves with respect to variation in input parameters E, b, and n_0 are similar to those for which s is temperature independent (Bos, 2001).

Many of the methods available in literature for the evaluation of E require the prior knowledge of b. In some case the shape and shift of peak intensities are used to predict b while in other cases the peak parameters are used for the evaluation of b. An expression for the evaluation of b for the case s (T) is scanty in literature. In this communication, we evaluate b using equation (19) for β =1 and 5 K/s. This equation was applied at various portions of the entire glow curves starting from the initial rise region. It was observed that the value of b obtained at the initial rise region was accurate when intensities within 10% of maximum intensities (I_m) were used only for order one. For higher orders, the most accurate b was found when intensities within 10% of I_m at the descending region of the glow curves were used. The values of b obtained at this region are given for in table 1 all input values of "a" and b considered in table1. The inaccuracy obtained at the initial rise region for all b except for b=1 could be due to the fact that at the initial rise region, b is about one (Ogundare & Chithambo (2006b). Furthermore, since b is a measure of re-trapping probability, at the initial rise region where re-trapping is negligible (Sunta, Feria, & Chubaci, 2005)), values of b evaluated at this region is expected to be inaccurate for b >1. It is worthy of note that equation (19) is similar to that obtained by Ogundare and Chithambo (2006a) although they did not consider the temperature dependency of s. The implication of this is that the equation is very valid for b irrespective of the temperature dependence of s and can thus be used for general glow curves. The values of b obtained in table 1 are very accurate for all values of 'a' and b except at a=0, 1 and 2 for input b=1 where there were negligible error of about 1%.

The values of the temperature index 'a' and activation energy 'E' obtained from equations (23) and (24) are given in table 2 and 3 respectively. It is obvious from the formulae that

the value of the kinetic order is required for evaluating the two parameters. The calculated values of the kinetic order in tab. 1, were used in the evaluations. Just as the case of the kinetic order, the accuracy of equations 23 and 24 were tested in different portions of the glow peak. At the descending part of the peak, the most accurate values of "a" and "E" had about 10% error in some cases, while on picking the three points from a mixture of ascending and descending point also yield considerable errors. The best result was obtained when the points are selected at the initial rise region of the peak within 10% of peak intensity. The result obtained for this region is thus presented on tab. 2 and 3. The values of the temperature index were very accurate and to the best of our knowledge we present for the first time a simple method for evaluating "a" for general order kinetics. The value of a, thus obtained could be used for correcting activation energy obtained using methods such as the IR (Aramu, Brovetto, & Rucci, 1966). The activation energy obtained from equations 23 and 24 should be free of errors introduced by neglecting the temperature dependency of "s". A possible source of error however could arise in reading the point on the glow peak for evaluating the trap parameters. The error introduced by inaccurate reading points on the glow curve will vary depending on the accuracy in reading the temperature (K) and the intensities on the glow peak. A comparison between the activation energy obtained using the method highlighted in this work and those obtained using the famous Chen's (1969) PS (E_T) and Booth (1954) and Bohun (1954) VHR methods for a= -1 for various values of b considered is given in table 4. In the formulation of these two methods, "a" was assumed to be zero; this could be responsible for the various errors in the evaluated E for the different b considered. Although both methods give fairly accurate results, the result obtained using the method introduced in this article is of better accuracy.

Conclusion

Most of the methods available for analyzing TL glow curves were formulated with the assumption that the frequency factor is temperature independent. This has led to considerable error in evaluated trap parameters in some cases. In order to obtain more accurate trap parameters, the temperature dependency of the frequency factor is considered in this work. A simple and practical way of determining the temperature index, order of kinetics and activation energy with better accuracy is introduced. It is however acknowledged that the algorithm suggested for the evaluation of trap parameters in this article, like most methods before it, is applicable to single and well isolated glow peaks. We therefore suggest that for this method to be applicable for multiple peaks glow curve, experimental procedures such as thermal treatment (Pagonis and Shannon, 2000) are applied for isolating the peaks before this method becomes applicable. It should also be mentioned that where computerize glow curve fitting is applied to multiple peak glow curve, the temperature index of the frequency factor can be considered as one of the fitting parameters.

Table 1: Values of the kinetic order obtained using equation (19) for various Input values of "a" and "b"

Input b	Calculated b			
	a=-1	a=0	a=1	a=2
1.00	1.000	1.010	1.010	1.010
1.10	1.100	1.100	1.100	1.100
1.20	1.200	1.200	1.200	1.200
1.30	1.300	1.300	1.300	1.300
1.40	1.400	1.400	1.400	1.400
1.50	1.500	1.500	1.500	1.500
1.60	1.600	1.600	1.600	1.600
1.70	1.700	1.700	1.700	1.700

1.80	1.800	1.800	1.800	1.800
1.90	1.900	1.900	1.900	1.900
2.00	2.000	2.000	2.000	2.000

Table 2: Values of temperature dependent index (a) obtained using equation 23 and 24 at various values of b

Input a	Calculated a										
	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0
-	-	-	-	-	-	-	-	-	-	-	-
1.000	1.000	1.000	0.916	1.001	1.000	1.000	1.000	1.000	1.000	1.000	1.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.002	1.000	1.000
2.000	2.000	2.000	2.000	2.000	1.822	2.000	2.000	2.000	2.000	2.000	2.000

Table 3: Values of activation energy using equations 23 and 24.

B	Calculated E			
	a= -1	a=0	a= 1	a=2
1.0	0.900	0.900	0.900	0.853
1.1	0.900	0.900	0.900	0.900
1.2	0.899	0.900	0.900	0.900
1.3	0.900	0.900	0.900	0.900
1.4	0.900	0.900	0.900	0.902
1.5	0.900	0.900	0.900	0.900
1.6	0.900	0.900	0.900	0.900
1.7	0.900	0.900	0.900	0.900
1.8	0.900	0.900	0.900	0.900
1.9	0.900	0.900	0.900	0.900
2.0	0.900	0.900	0.900	0.900

Table 4: Comparison of the activation energy E obtained using PS, VHR and that obtained from equations 23 and 24 at a=-1.

	E		
b	**PS Chen(1969)**	**VHR (Booth,1954;Bohun, 1954)**	**This work Equations 23 and 24**
1.0	0.865	0.869	0.900
1.1	0.854	0.887	0.900
1.2	0.909	0.865	0.899
1.3	0.943	0.825	0.900
1.4	0.971	0.906	0.900

1.5	0.851	0.972	0.900
1.6	0.882	0.959	0.900
1.7	1.090	0.833	0.900
1.8	1.020	0.853	0.900
1.9	0.976	0.911	0.900
2.0	0.975	0.814	0.900

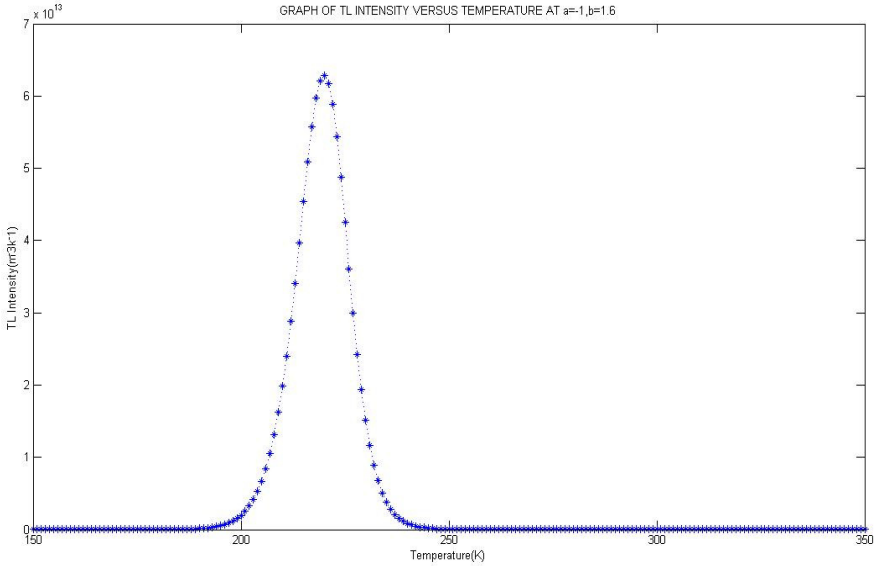

Fig.1: Simulated glow curve using equation (16) for a=-1 and b=1.4.

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SEROPREVALENCE OF HEPATITIS B VIRUS AMONG STUDENTS OF FEDERAL UNIVERSITY OF TECHNOLOGY MINNA, NIGER STATE, NIGERIA

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Abstract
This study was carried out to determine the seroprevalence of hepatitis B virus surface antigen (HBSAg) among students of Federal University of Technology Minna, Nigeria. Blood samples were collected from a total of one thousand (1000) students and screened using the one step Hepatitis B surface antigen test strip (Diaspot HBSAg). The screening revealed that 43 (4.30%) subjects out of the total 1000 screened were positive for HBSAg. The age distribution of HBV infection among the subjects showed that age group 17-20 years had 1 (0.3%) positive out of the 322 subjects screened, 21-24 years had 31 (8.1%) positive out of the 381 screened while 25-28 years had 11 (3.97%) positive out of the 297 subjects screened. The gender distribution of HBV infection revealed prevalence rates of 3.0% and 5.5% for the males and the females respectively. No significant difference was observed in the distribution of HBV infection with respect to age and sex in the study area ($p<0.05$). The result of this study suggests a declining trend in the prevalence of hepatitis B virus infection in the study area, it however underscores the need for a renewed campaign on the essence of vaccination against HBV.

Keywords: Surface, Screen, Hepatitis, Gender, Antigen.

Introduction

Hepatitis B is an infectious inflammatory illness of the liver caused by the Hepatitis B virus (HBV) that affects Hominoidea, including humans. Originally known as "Serum Hepatitis" (Barker et al., 1996), the disease has caused epidemics in parts of Asia and Africa, and it is endemic in China (Alshayea *et al*., 2006). About a third of the world population has been infected at one point in their lives (Navabakhsh, 2011), including over 360 million people who are chronic carriers of the virus (Musa *et al*., 2015). The diseases is hyper-endemic in Sub‑Saharan Africa accounting for an average of 80 infections per every 1000 persons and is believed to be a major cause of chronic liver disease in Africa and particularly Nigeria (Ola & Odaibo, 2007).

Hepatitis B virus is a member of the Hepadnaviridae viral family comprising viruses with a strong predilection for the liver and it has a circular genome of partially double- stranded DNA. The viruses replicate through an RNA intermediate form by a reverse transcription, an attribute which HBV shared with the retroviruses (Hu & Liu, 2017). Although replication takes place in the liver, the virus eventually spreads within the blood circulation where viral proteins and anti-HBV specific antibodies are found in infected people (Ayatollahi *et al*., 2014). The Hepatitis B virus is believed to be about 50 to 100 times more infectious than HIV (Kew, 2012). The virus is mainly transmitted by exposure to infectious blood or body fluids such as semen and vaginal fluids but viral DNA has also been reportedly detected in the saliva, tears and urine of chronic carriers. Perinatal infection is a major route of infection in endemic (mainly developing) countries (Franco, 2014).

Risk factors for developing HBV infection include working in a health care setting, blood transfusions, dialysis, acupuncture, tattooing, sharing razors or toothbrushes with an

infected person, travel in countries where it is endemic and residence in an institution (Kidd-Ljunggren *et al*., 2006; Sleisenger *et al*., 2016;). However, Hepatitis B viruses may not be spread by holding hands, sharing eating utensils or drinking glasses, hugging, coughing or sneezing. The acute illness causes liver inflammation, vomiting, jaundice and rarely death. Chronic Hepatitis B may eventually lead to liver cirrhosis and/or cancer (Hashem, 2012).

The infection is preventable by vaccination with a very cheap and effective recombinant DNA vaccine developed against hepatitis B virus in 1982 (Pongpapong *et al*., 2007). The vaccine has since been introduced into Nigeria for public health use in 1995 (Musa *et al*., 2015). This study was designed to investigate the prevalence of HBV among students of the Federal University of Technology, Minna to assess the success recorded so far since the introduction of the anti-HBV vaccination program

Materials and Methods

Study Population: The study was conducted among the students (both males and females) of the Federal University of Technology, Minna, Nigeria aged between the ages of 15 to 30 years. The choice of the study population was purposefully made to accommodate subjects born before and after the introduction of the vaccine as a public health intervention in Nigeria in 1995. Participation in the study by the subjects following an ethical approval by the University Health Service Unit was based on informed consent.

Sample Collection: Five Millilitres (5mL) of blood sample was collected from each subject through venepuncture using sterile syringes and needles. Each blood sample was transferred into a sterile EDTA bottle, labelled appropriately and transferred immediately to the laboratory of the Department of Microbiology, Federal University of Technology, Minna, Nigeria for HBV screening.

Sample Processing: Each appropriately labelled blood sample was centrifuged at 3000 revolutions per minute (rpm) for five (5) minutes to obtain serum. The detection of the HBSAg screening was done using a rapid, one step test kit designed for the qualitative detection of Hepatitis B surface antigen (HBSAg) in serum or plasma. The interpretation of the test result was done within 5-10 minutes and recorded.

Interpretation of Test Result

The one Step Hepatitis B Surface Antigen (HBSAg) Test (Serum/Plasma) is a qualitative, lateral flow immunoassay for the detection of HBSAg in serum or plasma. The membrane is pre-coated with anti-HBSAg antibodies on the test line region of the strip. During testing, the serum or plasma specimen reacts with the particle coated with anti-HBSAg antibody. The mixture migrates upward on membrane chromatographically by capillary action to react with anti-HBSAg antibodies on the membrane and generates a coloured line. The presence of this coloured line in the test region indicates a positive result, while its absence indicates a negative result. To serve as a procedural control, a coloured line will always appear in the control line region indicating that proper volume of specimen has been added and membrane wicking has occurred, as designed by Diaspot TM. The result is invalid if control band fails to appear, which may either arise from insufficient specimen volume or incorrect procedure or techniques used (Blumberg, 1971).

Data Analysis

Data obtained from the study were analysed using statistical analysis software (SAS) version 9.4. Chi-square analysis was used to determine the relationship between the rate of infection and the risk factors at 95% ($p<0.05$) confidence interval.

Results

Out of the total one thousand (1000) blood samples screened for Hepatitis B virus infection among student of Federal University of Technology, Minna, Nigeria, forty-three (43) students were found to be positive revealing a prevalence rate of 4.3%. Age distribution of HBV infection among students revealed that the age group (17-20), (21-24) and (25-28) years had 1(0.31%), 31(8.14%) and 11(3.70%) cases of HBV infection respectively (Table 1). The distribution of HBV with respect to sex of the students were, 15(3.04%) for the male students and 28(5.52%) for the female students as shown in Table 2.

Table 1: Age Distribution of HBV Infection among Subjects

Age Group	Number Tested	Number of Positive	Percentage Positive (%)
17-20	322	1	0.3
21-24	381	31	8.1
25-28	297	11	3.7
Total	1000	43	12.1

Table 2: Sex Distribution of HBV Infection

Sex	Number Tested	Number of Positive	Percentage Positive (%)
Male	493	15	3.0
Female	507	28	5.5
Total	1000	43	8.5

Table 3: Relationship between Age and Sex in HBV Infection

Factors	No of Positives	No of Negatives	p-values
Ages			
(1) 17-20	**1**	**321**	
(2) 21 – 24	**31**	**350**	**<0.0001**
(3) 25-29	**11**	**286**	
Sex			
(1) Male	**15**	**478**	**0.0533**
(2) Female	**28**	**479**	

Discussion

In this present study, 43 subjects out of the total 1000 screened for HBV were found to be positive giving a prevalence rate of 4.3%. Compared to the prevalence rates of 12.5% among students in the main campus of Ahmadu Bello University, Zaria, Nigeria (Aminu et al., 2013), 6.0% among students of the Federal University Wukari (Imarenezor et al., 2016), 8.0% among students of the University of Ilorin (Udeze *et al.*, 2015), 4.7% among students of the University of Uyo, Nigeria (Mboto and Edet, 2012) and 11.5% among students of the Nassarawa State University, Keffi (Pennap *et al.*, 2011) and considering WHO classification of HBV severity in environments where the disease is endemic (WHO, 2010), the prevalence rate of HBV infection in the study area may be considered as moderate. The moderate prevalence rate of the infection observed in this study may not be unconnected with the easy availability of the vaccine against HBV in the study area and the increasing awareness on the need to become vaccinated against the disease. However, considering the highly infectious nature of HBV, the prevalence rate of 4.3% observed in this study area remains public health problem that calls for continuous surveillance.

The distribution of the Hepatitis B virus infection observed on the basis of age revealed that the age groups 17-20, 21-24 and 25-28 years had a significant prevalence rates ($p > 0.05$)

of 0.31%, 8.14% and 3.70% respectively (Table 3). A finding regarding the prevalence of HBV infection by age has been similarly reported by Terwase and Emeka (2015) in parts of Abuja, Nigeria, with the age group 15-19 having a low prevalence rate compared to the older age groups. The low prevalence rate of the infection among the <20 age group who are mostly fresh in the university may not be unrelated to their reduced level of exposure to sexual activities, tattooing and incision made during societal initiation because of parental control. The high rate of infection observed among subjects within the (21-24) age group on the other hand which is in agreement with the previous finding of Imarenezor *et al*. (2015) in a study carried out among the students of the federal University of Wukari, Nigeria, may be due to the high rate of sexual activities and tattooing that commonly characterize this age group because of reduced parental control and the increased freedom occasioned by university life.

The distribution of HBV infection on the basis of gender revealed that the rate of HBV infection was higher among the females (5.52%) compared to the males (3.04%). This finding differs from the findings of the majority of earlier studies (Mehmet *et al*., 2005; Balogun *et al*., 2009; Terwase & Emeka, 2015; Imarenezor *et al*., 2016) in which males were reported as having the highest rates of infection. This difference with earlier studies may not be unconnected with the tendency to promiscuity among some female students of high institutions of learning who engage in sexual activities with multiple partners for monetary benefit. Another reason may be the increasing trend of tattooing among females which was hitherto unknown.

Conclusion

It may be concluded, that while anti-HBV vaccination maybe making an impact on the spread of HBV, the progress being made through vaccination is really slow. It is therefore recommended that HBV screening should be an important component of the registration process for tertiary institutions so that those who are found to be negative may be compelled to take the vaccine to avoid future infection. There is also the need for the creation of awareness on the availability of anti-HBV vaccine as well as the implication of infection with HBV.

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DATA MINING INCORPORATION FRAMEWORK FOR COMBATING ELECTRONIC FRAUDS IN NIGERIA

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Abstract
Fraud has become headache the world over. In this paper we propound Data Mining Incorporation Framework (DMIF) that can assist governments through their anti-graft agencies, in combating the heinous fraudulent practices, particularly in financial institutions. To do this end, we review a number of financial fraud cases (FFCs) in Nigeria as a particular case where financial fraud has become a serious problem in the business of government. Some of the different data mining techniques which are applicable to this problem are reviewed. The structure of these techniques as it can be applied to assist government to reduce this menace is designed. The analysis of fraud cases clearly shows that frauds are prevalent in Nigeria and the design will no doubt help in the fight against the menace.

Keywords: Anti-graft agency, Framework, Fraud schemes, Data mining, Incorporation

Introduction

The world over, frauds, particularly the financial aspects, have become "more than a persistent headache", that would not allow anyone to rest. Various bodies: security outfits, regulatory agencies, anti-fraud bodies, governments and so on, have reported cases of high profiles of financial fraud cases. These frauds are perpetrated by means of falsifying techniques that appear to be true in the face of the victims. Fraud is a global phenomenon that has been in existence long before now, and has continued to increase geometrically. Nwankwo (2013) has defined fraud as a deliberate act that causes a business or economy to suffer damage, often in the form of monetary losses. Fraud has also been defined as a deliberate act by one or more individuals among management, employees or third parties which results in a misrepresentation of financial statement (Nwankwo, 2013; Adeniji, 2004).
Financial fraud is posing a progressively more threat to economy globally. A striking case in Ponzi scheme, perpetuated by the former NASDAQ chairman, Bernard Madoff, led to the loss of about US$50 billion worldwide (FBI, 2008). Another outstanding case is that of Joseph Hirko, former co-chief executive officer of Enron Broadband Services (EBS), who after pleading guilty to wire fraud, avowed to forfeit approximately US$8.7 million in restitution to Enron victims through the U.S. Securities and Exchange Commission's Enron Fair Fund (FBI, 2008). In 2007 BBC news report (BBC, 2007), fraudulent insurance claims cost UK insurers a total of 1.6 billion pounds a year.

Apparao et al. (2009), state that financial statement frauds (FSF) have received considerable attention from the public, the financial community and regulatory bodies because of several high profile frauds reported at large corporations such as Enron, Lucent, and WorldCom and Satam computers over the last few years. Fabricating financial statements primarily consists of elements manipulation by overstating assets, profit, or understating liabilities. The use of normal audit procedures to detect management fraud is quite a difficult task (Coglitore & Berryman, 1998). Fanning and Cogger (1998) argued that detecting management fraud is difficult because: firstly, there is a shortage of knowledge concerning the characteristics of management frauds; secondly, most auditors lack the experience necessary to detect such

frauds; finally, financial managers and accountants are deliberately trying to deceive the auditors. For such managers, with limited knowledge of an audit system, standard auditing procedures may be insufficient. These limitations suggest the need for additional analytical procedures for the effective detection of false financial statements (Apparao et al., 2009).
The perpetration of fraud is particularly rude in Nigeria that many took place undetected and the few ones detected went unpunished, practically because in most cases for lack of enough evidence against the suspects. More so, some affected individuals or managements are usually reluctant to release adequate information on fraud as it affects them (Owolabi, 2010). In the eighties, organized crime elements with ties to Nigeria have come to dominate crime emanating from West Africa. These criminal groups, also known as Nigerian Crime Enterprises (NCE's), have become adept at executing transnational criminal activities, including fraud schemes directed against the United States (Jim & Alex, 2001). The choice of Nigeria is borne out of incessant cases of financial fraudulent activities against various financial sectors, particularly the banking sector. Experts claimed that most of these sham activities are taking place unreported. The fear now is that the increase rate of fraud in the financial institutions, if not arrested might pose certain threats to the stability and the survival of individuals, financial institutions and the performance of the industries as a whole and no area of the economy would be immune from fraudsters (Nwankwo, 2005).

Detecting frauds is not an easy task as the criminals themselves are knowledgeable and smart using such tools as Internet facilities. This situation not only requires adequate information and knowledge, but also an improved designed structure, (such as DMIF proposed here) if a riposte against this menace is to be made. Data mining and statistical methods have been proved to successfully detect fraudulent activities such as money laundering, e-commerce credit card fraud, telecommunications fraud, insurance fraud, and computer intrusion (Apparao, 2009).

According to "Oxford Dictionary" (2010), a government is the system by which a state or community is governed. Government of any kind affects every human activity in many important ways. If this is so, then there is the need for government to put deliberate and practical measures in place (through its various anti-graft agencies) to see that its people are financially protected. In this paper, we propose a financial fraud detection structure called Data Mining Incorporation Framework (DMIF) which can be used by the Nigerian government (not restricted to it), through its various anti-graft agencies in its war against frauds.

In this paper, it is established that fraud is really on alarming rating, and this proposed framework would in no small measures assist in the fight against this dreadful menace if applied. The rest of this paper is organised as follow: Section 2 dwells on the review of related literatures; In section 3, the proposed framework is propounded; Section 4 deals with the discussion of results; and the paper is rounded up through conclusion and recommendations in Section 5.

The Review of Related Literatures

In the field of data mining and fraud, a lot of research works are taking place. In this work, a number of literatures have been reviewed in subsections as follow.

Related Works

The role of data mining in financial fraud detection (FFD) cannot be overemphasized, as it is often being applied to extract and uncover the hidden truths behind very large quantities of data. Data mining has been defined as a process of identifying interesting patterns in databases that can then be used in decision making (Bose & Mahapatra, 2001). Turban et al.

(2007) describe data mining as a practice that uses mathematical, machine learning, artificial intelligence and statistical skills to extract and identify useful information and subsequently gain knowledge from a large database. Frawley et al. (1992) opined that the objective of data mining is to obtain valuable, non-explicit information from data stored in large repositories. An important advantage of data mining has been seen as its capability of being used to develop a new class of prototypes to identify new attacks before they can be detected by human experts (Kou et al., 2004).

Quite a great number of publications on the use of data mining techniques in fraud detections are available. All these are efforts expended, or contributions made to fight against the menace of fraudulent practices (particularly the financial ones, which are most rampant) that are ravaging the entire globe. Fraud detection has been identified as one of the best established application areas of data mining in both industry and government (Phua et al., 2005). According to Ngai et al. (2011), financial fraud detection (FFD) is vital to the prevention of the often devastating consequences of financial fraud. He argued that, FFD involves distinguishing fraudulent financial data from authentic ones, thereby disclosing fraudulent behaviours or activities and enabling decision makers to develop appropriate strategies to decrease the impact of the fraud. Rekha (2011) used decision tree and Bayesian Network techniques of data mining, to detect frauds in an auto insurance company. Tarjo and Nurul (2017), analysed the performance of two data mining methods in detecting financial fraud based on Beneish m-score model. The results obtained thereby were found pretty interesting.

The approach here is to use data mining in conjunction with existing procedures (of anti-graft agencies) put in place by Nigerian government. This approach is, however, not restricted to fraud detection application in Nigeria alone.

Fraud Schemes in Nigeria

Jim and Alex (2001) reported that according to the Secret Service, one quarter of the major fraud scams it probes now involve Nigerians, resulting in loss of hundreds of millions of dollars and with United States being the pet target. These frauds have a number of variants, some of which are briefly clarified as follows:

(i) Advance Fee/"419" Scam or Fraud

The most notorious of Nigerian scams is the advanced fee fraud scheme known as the "419"scheme (Jim & Alex, 2001). "The Economist," (2013) describes the number 419 ("four-one-nine") as a verb, a noun, a way of life, a cliché and a curse in Nigeria. It refers to a section of the criminal code that proscribes seeking money for non-existent benefits (FBI, 2013; The Economist, 2013; & Nigerian scams, 2012). A scam victim will usually receive an email making an offer of a large sum of money. While the stories may vary slightly, the general plot then talks of a person who has come across a large sum of money and needs your assistance to get the funds out of the country, with a promise to share in the money.

(ii) Black Money Fraud

A recent variation on the Advance Fee scheme is known as the "black money" scheme. This category of scam is sometimes also known as the "wash scam" (BMS, 2017). It is a scam where con artist attempt to fraudulently obtain money from a victim by persuading him or her that piles of banknote-sized paper in a trunk or a safe is really money which has been dyed, for instance, to avoid detection by security agents. The victim is persuaded to pay for chemicals to wash the "money" with a promise that he will share in the proceeds.

(iii) Access Device Fraud

Access device fraud is another Nigerian fraud. The fraud typically begins with the leasing of a commercial mail box with false name. The crook applies for hundreds of credit cards each day, with the fraud mail box, thereby growing exponentially as the cards arrive (Jim & Alex, 2001). Even though the checks are fraudulent, the credit card companies are required to give immediate credit on the opened account (Jim & Alex, 2001). This allows the thief to obtain even more cash advances and open more bank accounts. Once funded, the criminal forwards a wire transfer order directing the investment company to forward the funds to a bank account under his control.

(iv) Identity theft fraud

Identity theft is one of the frauds prevalent in Nigeria. According to (FBI, 2013), it occurs when someone assumes your identity to perform a fraud or other criminal act. Scandals can get the information they need to assume your identity from a variety of sources, from stealing of wallet through compromising of credit or bank information. You can also be approached in person, by telephone, or on the Internet and ask you for the information.

(v) Bank fraud

These scams are often coordinated with stolen and counterfeit checks. They occupy a large part of the Nigerian fraud space (Jim & Alex, 2001). Armed with computer, and computing facilities, the Nigerian fraudster can print corporate checks in any dollar amount with an authorizing signature that is virtually identical to the original. By recruiting co-conspirators and opening multiple accounts, including some in assumed business names, and a bank insider, an enterprising Nigerian fraudster can operate without fear of getting caught. Once the insider finds an account with a large balance, the account information is compromised and forwarded to the criminal (Jim & Alex, 2001), who issues orders directing the bank to transfer large sums into accounts under his (fraudster) control.

Data Mining Process Model in Financial Fraud Detection

The objective of Data Mining is to find out information with special meaning from large volumes of data using special technologies as the procedure to discover knowledge through data selection – taking out data related to the subject from the database, data pre-processing – putting data in form ready for transformation, data transformation - conversion of the selected data/information into the form appropriate for mining, data mining – extraction of data models by the utilization of technology, pattern evaluation – appraisal of the usefulness of the model to present knowledge, and Knowledge presentation – production of knowledge to the users, using technology such as visual presentation.

The adoption of the mining procedure to discover unknown knowledge and rules from plentiful data is the role of data mining (Han & Kamber, 2001). Consequently, data mining which is part of an iterative process called knowledge discovery in database, would be very useful in extracting knowledge automatically from large volumes (databases) of fraud data from the various sections of fraud, which will be of enormous importance to the various anti-fraud agencies in assisting them to combat the frauds in Nigeria. Data mining has a generic process model it follows in mining data from databases and discovering knowledge successfully for presentation to, and use by users. The anti-fraud agencies can also adopt this process model in order to record success in their struggle to fight this menace. See Figure 1, for a form of a generic process model (James, 2003). Some of the techniques used in data mining in discovering knowledge from the database are enumerated below. The descriptions of these techniques here, are as related to this research work.

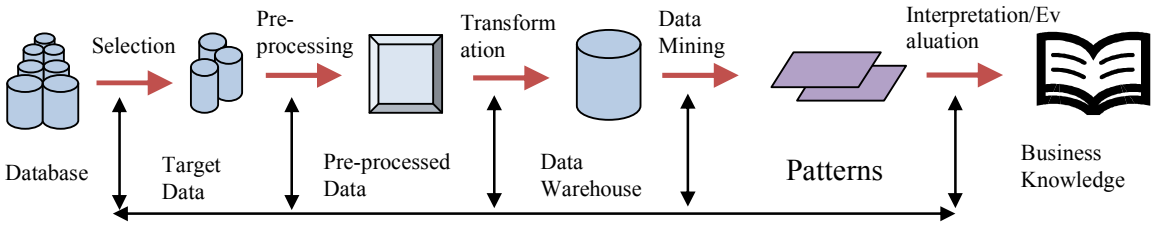

Figure 1: How Data Mining Extracts Business Knowledge from a Data Warehouse

1. Classification

Classification is the most commonly applied data mining technique, which employs a set of pre-classified examples to develop a model that can sort the population of records at large (Bharati, 2010). Fraud detection and credit risk applications are particularly well suited to this type of analysis. For a fraud detection application, this would include complete records of both fraudulent and valid activities determined on a record-by-record basis

2. Clustering

Clustering can be said as identification of similar classes of objects. By using clustering techniques we can further identify dense and sparse regions in object space and can discover overall distribution pattern and correlations among data attributes (Bharati, 2010). For example, to form group of customers based on purchasing patterns, to categorize genes with similar functionality, and to group fraud data.

3. Predication

Regression technique can be adapted for predication. It can be used to model the relationship between one or more independent variables and dependent variables (Bharati, 2010). In data mining, independent variables are attributes already known and dependent variables are what to predict. This model can be adopted to predict fraud data.

4. Association rule

Association and correlation are usually used to find frequent items from among large data sets. This type of finding helps businesses to make certain decisions, such as catalogue design, cross marketing and customer shopping behavior analysis (Bharati, 2010). It is also used to associate fraud data distinguish between fraud and legal data.

5. Neural networks

Neural network is a set of connected input/output units, each with a weight (Bharati, 2010). During the learning phase, network learns by adjusting weights so as to be able to predict the correct class labels of the input data. Neural networks have the remarkable ability to derive meaning from complicated or imprecise data and can be used to extract patterns and detect trends that are too complex. It has particularly been used to distinguish fraud data from legal ones, and in many other application areas.

6. Visualization

Visualization refers to the easily understandable presentation of data and methodology that converts complicated data features into clear patterns so as users can view the complex patterns or relations uncovered in the data mining process (Turban, 2007). The researchers have exploited the pattern detection capabilities of the human visual system by building a suite of system that flexibly encodes data using visual characteristics. Complex patterns are best delivered through the clear presentation of data or function, using visualization techniques (Eick, 2014).

The Research Structure (Framework)

The number of disclosures of frauds linked to Nigeria has remained quite high in recent years Apparao et al. (2009). Criminals perpetrate these acts following certain arrangements. As criminals grow more sophisticated, government (through its anti-graft agencies) must leverage more powerful tactics to keep up. Although, no analytical tool can ever fully replace analysts or investigators, it can suggest which facts stand out and which are most likely to be important in fraud data analysis. As sources of information grow in number, kind and size, what seemed like a "haystack" has started to look like a "mountain" (IBM, 2012).. Data mining techniques have the capacity to deal with large volume of data, analyzing the data and bringing out the various patterns in data. They can group data into various forms to identify variations among them.

Here we present a "Data Mining Incorporated Framework" (DMIF), to aid fraud detection that we hope would assist government to fight frauds through its agencies and others (see Figure 2). Some fraud instances are discussed in section 4. In this approach, data mining techniques (tools) are brought to assist the various agencies and their allies in confronting the danger of frauds. Our approach uses data mining techniques to obtain patterns from large volumes of financial database systems using knowledge discovery process (see Figure 1). From the various financial database systems, data is collected (to obtain target data) and then cleaned. The stage is then set for selection and transformation. The transformed data is stored in a special database called Data Warehouse. Data mining techniques are then applied to extract patterns from the fraud data. The pattern is presented to the experts for evaluation. This process is repeated until found satisfactory. The patterns, if satisfactory become knowledge for usage by the various anti-fraud agents. The various agents take appropriate actions and reviews when necessary. The agents involved in the fight against frauds include; Bank management, Economic and Financial Crimes Commission (EFCC), Independent Corrupt Practices Commission (ICPC), Directorate of Security Service (DSS) and others.

These agents can always sit together to share and review knowledge, to better their knowledge for the challenge before them. This coordinated effort will help in no small measures to fight against the danger of frauds.

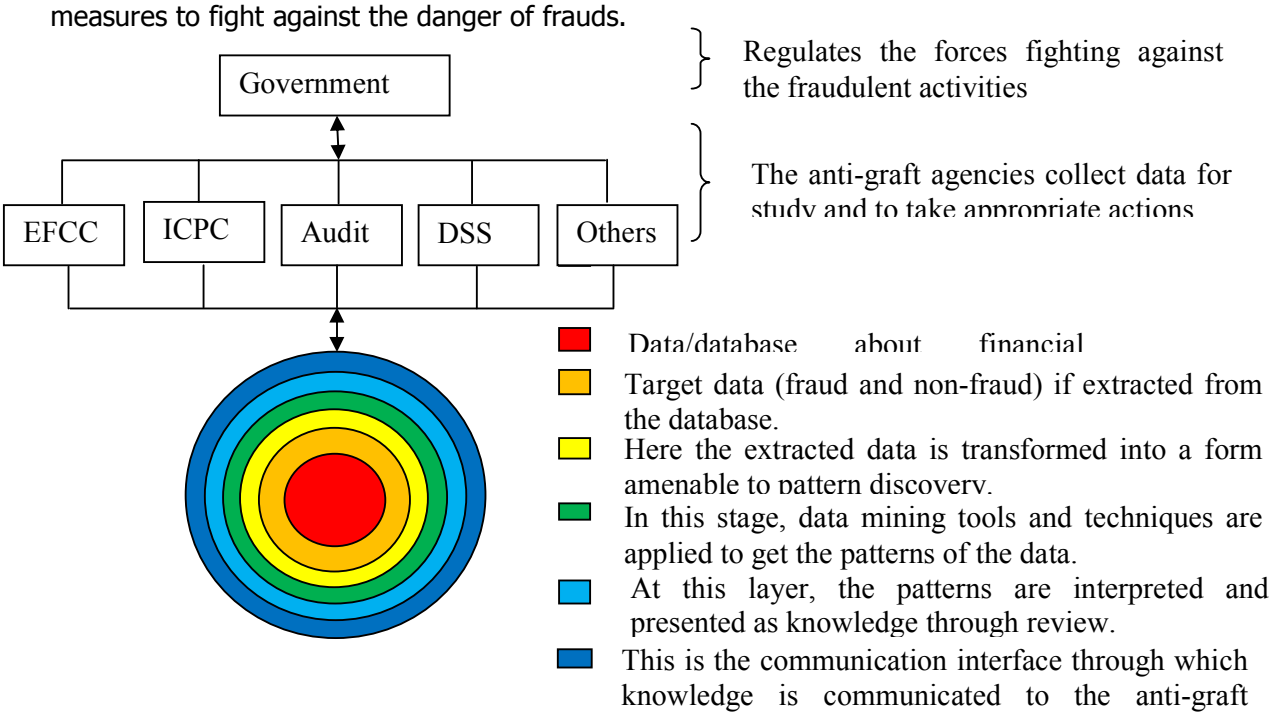

Figure 2: A Data Mining Based Incorporated Framework for Fraud Detection.

Analysis and Discussion of Frauds

Fraud in Nigeria is no longer news to the entire Globe. So many fraud cases in Nigeria including the ones perpetrated against other countries particularly the United States have been reported. Here we analyse and discuss some few cases to appreciate the level of frauds in Nigeria.

The Economic and Financial Crimes Commission (EFCC) reported a case of how a former manager of the defunct Oceanic Bank, Udusegbe Omoefe Eric, allegedly connived with a principal staff of Pension Accounts in the Office of the Head of Service of the Federation (HSF) to steal N1.9 billion pensions in three months (Godwin, 2013).

The Nigerian Deposit Insurance Corporation reported just this year, that the Nigeria Banking Industry recorded 3,380 cases of fraud valued at about ₦18bn, with contingent or expected loss standing at ₦4.52bn, in 2012 alone as against expected loss of ₦4.072bn reported in 2011 (Ifeanyi, 2013). This shows an increase of ₦445m or 10 percent.

According to the Executive Director (Godwin, 2013), Business Development, Nigerian Inter-bank Settlements Systems, NIBSS Plc, the Nigerian Banks have suffered a loss of ₦59 bn to e-frauds between the years 2000 and the first quarter of 2013. For space consideration, we summarize the year by year loss as shown in Figure 3

Table 1: Summary of e-fraud suffered by Nigerian Banks between the years 2000 and 1st quarter of 2013

S/N	Year	Loss (BN Naira)	Change (BN Naira)
1	2000	1.65	
2	2001	3.12	1.47
3	2002	8.2	5.08
4	2003	5.13	-3.07
5	2004	89.43	84.3
6	2005	6.76	-82.67
7	2006	2.74	-4.02
8	2007	8.51	5.77
9	2008	34.5	25.99
10	2009	21.72	-12.78
11	2010	14.96	-6.76
12	2011	24.43	9.47
13	2012	10.06	-14.37
14	2013	7.5	-2.56

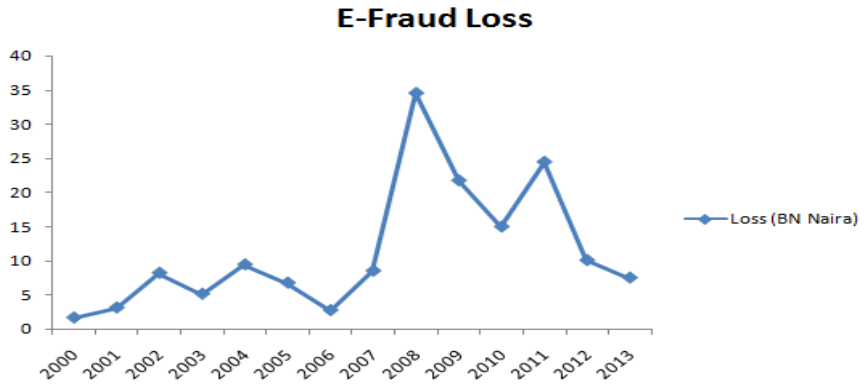

Figure 3: Line Chart of e-fraud suffered by Nigerian Banks between the years 2000 and 2013

All amounts are in Billion Naira (₦). Positive and negative figures in the change column of Table 1 indicate increase and decrease respectively, in the e-fraud of that year from the previous year. Year 2000 has the lowest loss while 2008 has the highest.

Owolabi (2010), reported major fraud and forgery types in Nigerian Banking Industry between 2003 and 2005, from researchers' compilation from Central Bank of Nigeria (CBN) reports of 2003 – 2005 (see Table 2).

Table 2: Compilation from CBN reports: 2003 - 2005

	2003 (₦'M)				2004 (₦'M)				2005 (₦'M)			
Types of Fraud	Freq.	Amount involved	Actual loss	%	Freq	Amount involved	Actual loss	%	Freq	Amount involved	Actual loss	%
Granting of Unauthorized Loans/overdraft	24	222.67	19.45	2.66	25	702.97	59.15	11.32	21	2,601.69	1,413.75	24.53
Presentation of Forged Cheques	249	2,269.91	24.41	27.09	368	1,759.90	547.02	28.33	418	2,632.45	628.82	24.82
Posting of Fictitious Credit	16	93.63	21.58	1.12	58	311.10	88.75	5.01	43	670.31	924.69	6.32
Loss of Money to Armed robbers	40	597.2	81.81	7.13	55	333.87	296.39	5.37	61	566.37	708.07	5.34
Fraudulent Transfer and Withdrawals	283	4,370.2	347.17	52.16	309	2,382.48	560.45	38.36	365	2,673.37	759.10	24.87
Outright Theft	48	179.81	43.55	2.15	49	188.45	45.56	3.03	33	160.15	235.75	1.51
Suppression of Cash/cheques	113	644.51	134.6	7.69	201	532.57	207.10	8.57	171	1,054.25	930.84	3.13
Attempted Fraud									117	331.77	0	3.13
Total	773	8,377.93	857.46	100.00	1,065	6,211.34	1,804.42	100.00	1,229	10.606.18	5,602.02	3.13

Source: Researcher's Compilation from CBN reports 2003 - 2005

With this analysis/discussion (section 4), we can appreciate the level of frauds and fraudulent practices going on in Nigeria. Although, Nigerian Government does not relent in its efforts to fight these criminals, there is the need to strengthen its efforts in order to win the battle against these criminals. It is believed that this methodology, DMIF, coupled with the existing measures, will assist the government, greatly in battling the cheats, since data mining contains such techniques as classification, regression, neural network, clustering, prediction, association rule and visualization, one or more of which have the capacity to detect patterns of any fraud data type. This will help the government to regain its image and win back the confidence of its investors, mainly, the foreign ones.

Conclusion and Recommendation

Fraud incidences have continued to grow in Nigeria despite the efforts from several institutions and anti-graft agencies to fight against these sharp practices. It, therefore, suggests that there is the need to intensify efforts, such as a collaborated and coordinated one like the type suggested by this approach (DMIF). It is suggested in this method that data mining tools or techniques be incorporated into existing framework employed by the various institutions and anti-graft agencies. The incorporation of data mining techniques would better their understandings to readily distinguish between the fraud data and the legal ones. It will also allow all the fraud fighters to communicate in common platform and share ideas easily.

In the findings, it is observed that monetary organizations, particularly the banking sectors are mostly targeted. It is, therefore, suggested that more research efforts in collaboration with the banking sectors and all other stakeholders be geared towards this direction to find a hallmark solution to this danger of frauds. Our further research direction would be direct involvement of the various anti-graft agents involved, and not only rely on the literatures.

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EVALUATION OF TREND IN FLOOD EVENTS ON RIPARIAN COMMUNITIES OF SHIRORO DAM, NIGERIA

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Abstract
With reference to global climate change which possibly causes heavy downpour, river erosion have led to upstream dam sedimentation, overflowing and large volume of water into Shiroro dam from the main river and its tributaries which may have been causing upstream spill over (back flow) water and also force the dam managers to release large volume of water to downstream sector in order to safe the dam from collapse. In the course of doing that, the downstream communities are exposed to river bank over flow into their houses, farmlands and displacement. Therefore the aim of this study was to evaluate the trend in flood events on riparian communities of Shiroro dam, Nigeria. The techniques used for data analysis were different statistical techniques such as Analysis of Variance (ANOVA), Regression analysis, percentage, frequency tables and graphs. The result shows monthly rainfall of August for 26 years (1990 to 2015) and the monthly rainfall tends to be increasing from 174.1mm in 2005 to 443.8mm in 1995. This has translated to more flooding activities in the study area due rise in inflow and outflow data. Recently, August for the years 2012, 2014 and 2015 has high monthly rainfall and the people in the study area confirmed that it resulted in more flooding activities with resultant effects on infrastructure, farm produce and lives of the inhabitant living in the area. The finding also shows that R^2 was 0.52 for annual rainfall, thus, rainfall account for 52.0% of the explained variance between annual rainfall and annual Inflow in the study area. This shows that other climatic variables like temperature and relative humidity also play important role in Inflow data since there is remaining 48%. It's therefore recommended that town planners as well as NSEMA specify habitable and non-habitable area in riparian communities of Shiroro dam so as to avoid the flood hazard from affecting the lives and properties of the people.

Keywords: Flood events, Riparian communities, Rainfall, Inflow, Outflow and Shiroro dam

Introduction

International Water Power and Dam Construction (IWPDC) (2011) offered definitions of dam as an enlarged natural or artificial lake, storage pond or impoundment created using a lock to store water. Dams can be created by controlling a stream that drains an existing body of water. They can also be constructed in river valleys and gorge as in the case of Shiroro dam on Kaduna River and Shiroro gorge. Alternatively, a dam can be built by excavating flat ground and/or constructing retaining walls and levees. IWPDC (2011) added that, dams can be used in a number of ways to control how water flows through downstream waterways: Downstream water supply (ii) Irrigation (iii) Flood control (iv) Canals (v) Recreation.

Etuonovbe (2011) defined flood as an overflowing of the great body of water over land not usually submerged. It is an extreme weather event naturally caused by rising global temperature which results in heavy downpour, thermal expansion of the ocean and glacial melt which in turn result in rise in sea level, thereby causing salt water to inundate coastal lands. Caribbean Disaster Emergency Management Agency (CDEMA) (2010) offered definition of flood as an abnormal progressive rise in the water level of streams or rivers which may result in the overflowing. Floods in the Caribbean can often be caused by heavy rainfall, dam or levee failures, tsunamis, storm surges or burst water mains. Mitigation on the other hand, is perceived as any structural or non-structural measure undertaken to limit the adverse impact of flood. UNESCO and WMO (1992) defined flood as relatively high flow

as measured by stage height or discharge. According to Deyer (1988), all rivers are subject to flooding in the hydrological sense of inundation of riparian areas by stream flow that exceeds bankful capacity. In water resources engineering practice, flood is defined as unusually high stage. It is a flow of water in a river or stream channel beyond the capacity of that channel to carry, the excess overflowing the banks to form flood water hazards.

According to Ologunorisa and Abawua (2005), the obvious reason for flooding especially in municipalities and coastal areas in Nigeria lies in the wide distribution of low-lying coastal areas and river floodplains and because these areas have fast become a long standing attraction for human settlement, which Ojigi *et al,* (2013) concluded that this subsistence attraction has become a high risk factor in most part of Nigerian floodplain regions. On the causes and impacts of flood hazards, Ojigi *et al,* (2013) asserted that flood hazards are natural phenomenon, but the damages and losses from floods are the consequences of human actions because it has been known that floods can be caused by anthropogenic activities and human interventions in the natural processes such as increase in settlement areas, population growth and economic assets over low-lying plains prone to flooding which may lead to alterations in the natural drainage and river basin patterns, deforestation and climate change. Following the annual increase of flood disaster especially the devastating 2012 flood hazards in Nigeria coupled with improvement in the use of modern technologies for environmental monitoring such as remote sensing and GIS, the government of Nigeria and the relevant agencies such as National Emergency Management Agency (NEMA) and National Research Space and Development Agency (NARSDA) have recently put all efforts on environmental monitoring and management especially flood disaster (Ikusemoran *et al.,* 2013). Therefore this study evaluate trend in flood events on riparian communities of Shiroro dam, Nigeria.

Statement of the Problem

With reference to global climate change which possibly causes heavy downpour, river erosion have led to upstream dam sedimentation, overflowing and large volume of water into Shiroro dam from the main river and its tributaries which may have been causing upstream spill over (back flow) water and also force the dam managers to release large volume of water to downstream sector in order to safe the dam from collapse. In the course of doing that, the downstream communities are exposed to river bank over flow into their houses, farmlands, displacement etc. Similarly, with increasing population in the study area, human activities through deforestation due to farming, fuel wood demand, grazing and local mining at the upstream sector may lose the soil for easy runoff and erosion causing upstream sedimentation thus, back flow flood (Lawal & Nagya, 2009).

Several researches have been carried out on trend in flood events across the world and in Nigeria; notable among them are the works of Adger (2008) on Disaster risk reduction, Climate change adaptation and human security in Norway; International Strategy for Disaster Reduction (ISDR) (2009) on United Nation International Strategy for Disaster Reduction (UNISDR); European Union (EU) (2011) on Environmental Impact Assessment and its Amendments in Europe; World Commission on Dams Report (WCDR) (2013) on Dam Structure for Water Impoundment; Mohan (2008) on National Disaster Management Guidelines, Management of Floods in India; Abubakar (1997) on Environmental Impact Assessment of Shiroro Dam some hydrometeorological variables in the Kaduna River Basin; Salami and Sule (2010) on overview on Reservoir Operational Impact of Kainji, Jebba and Shiroro Dams on the environment; Usman and Ifabiyi (2012) on Socio economic Analysis of the Operational Impacts of Shiroro Hydropower Generation in the lowland Areas of Middle River Niger; National Emergency Management Agency (NEMA) (2012) on Nigeria Lost N2.6 trillion to 2012 Floods Disaster. Studies have also been carried out by Zago (1999),

Tyabo (2005), etc. on the hydrological, ecological and climatological impact of Shiroro dam to the immediate environment. None has been carried out on trend in flood events on riparian communities of Shiroro dam, Nigeria which is part of the missing gap that this paper was intended to fill. Therefore the aim of this study was to evaluate the trend in flood events on riparian communities of Shiroro dam, Nigeria.

Study Area

Shiroro Hydroelectric Dam is situated in confluence between Rivers Kaduna and Dinya within Shiroro Local Government Area of Niger State. The lake is located on River Kaduna at the Confluence of Kaduna River and Dinya River. The lake is located on Latitude 8°51′01″N to 10°20′04″N and Longitude 5°50′01″E to 07°10′41″E (See Figure 1) Kaduna River is the major River feeding the lake. The River takes its source from the west and Northwest of Jos Plateau. The river flows westward from the plateau at an elevation of 1,500 metres to 1,800 metres through Kaduna town at an elevation of 633metres, the major left hand tributaries of the Kaduna River at the upstream of Shiroro reservoir are the River Sarkin/Pawa and River Dinya. They rise from hilly areas within the basement complex plains near Kaduna (Garba and Mohammed, 2011).

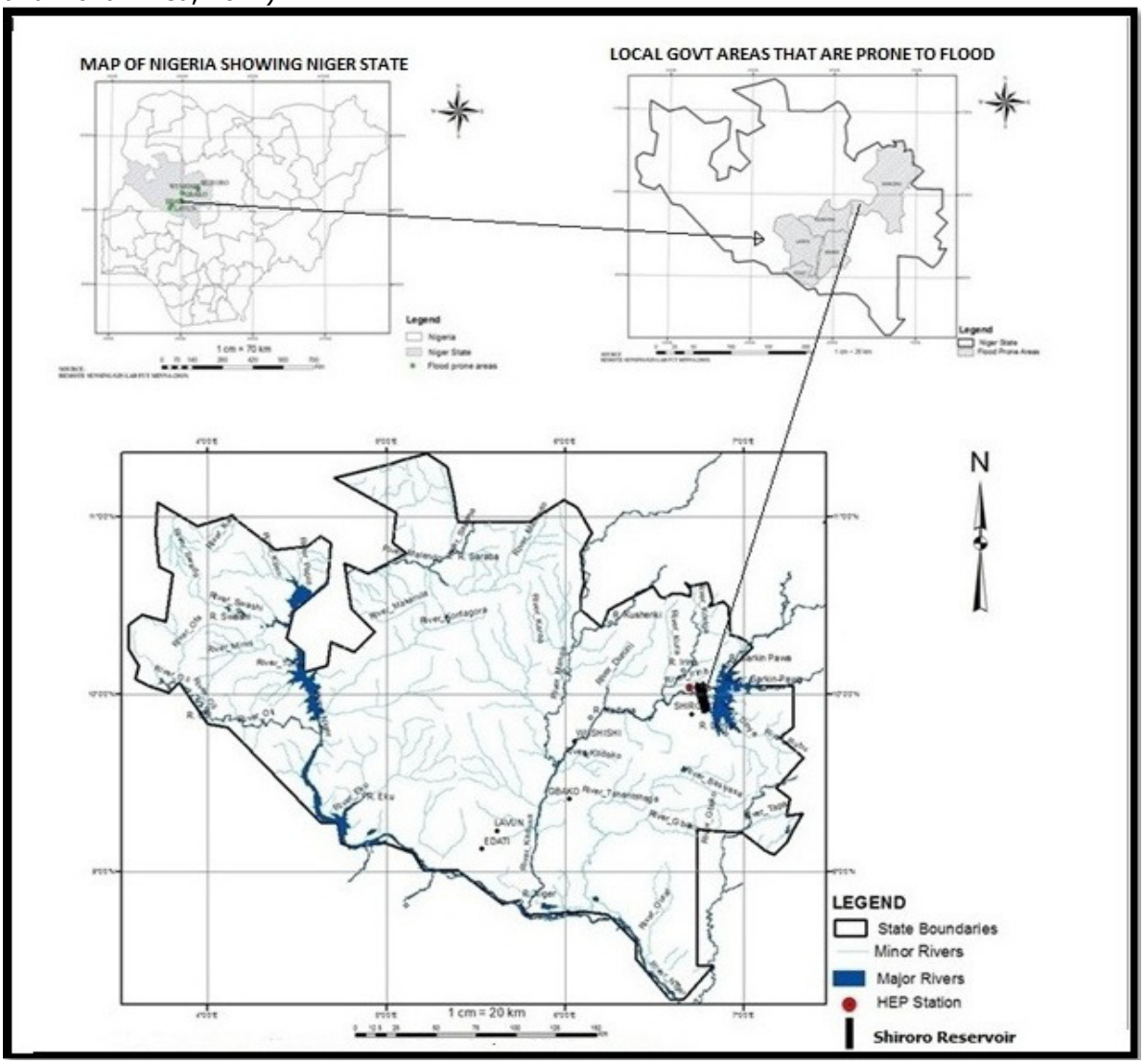

Figure 1: Location of Shiroro dam on River Kaduna and its tributaries

Materials and Methods

The techniques used for data collection and analysis of flood disaster management study of upstream and downstream communities of Shiroro Dam in Niger State include reconnaissance survey and used annual rainfall, in-flow and outflow data. To achieve the aim of this study which was to examine the trend in flood events in the study area; annual rainfall data from 1990 to 2015 as well as in-flow and out-flow data for the same period were sourced from Shiroro Hydroelectric Power Station (SHPS) in Hydrology Department and Nigeria Meteorological Agency NIMET (Abuja airport or Minna airport). The study used tables to show the rainfall amount, in-flow and out-flow data from the dam and the mean total annual rainfall occurrence in millimeters to identify the most wet and drought seasons which could have possibly caused flood or not in the study area. Also a trend in flood events was determined from the above secondary data. Different statistical techniques such as Analysis of Variance (ANOVA), Regression analysis, percentage, frequency tables and graphs were used for flood trend and analysis of effects.

Results and Discussion

As shown in Figure 2, mean monthly rainfall for the period under study (1990 - 2015) tend to be increasing, higher in the months of August to September and the least in the months of January to February.

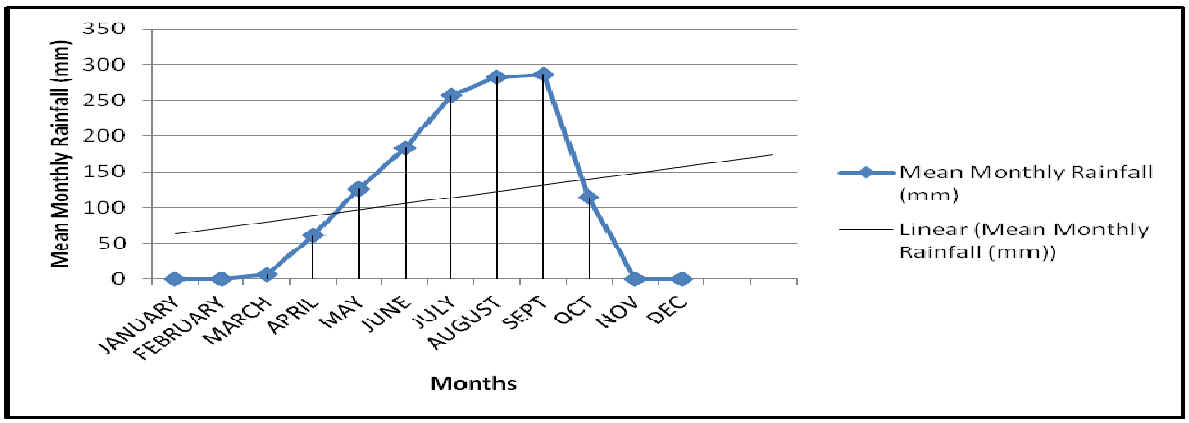

Figure 2: Mean Monthly Rainfall of the Study Area
Source: Authors Data Analysis, 2016

The highest monthly rainfall was in the month of August with a value of 282.58mm and the least were in the months of November to February with a value of 0.0mm. The highest monthly rainfall has lead to flooding in both up and downstream of the study area and this was as a result of more rainfall which have lead to more inflow and outflow within the operational area of Shiroro dam, thus, this process have been leading to frequent flooding in the months of July to September. This implies that its only in wet season that flood events occurred in the study area.

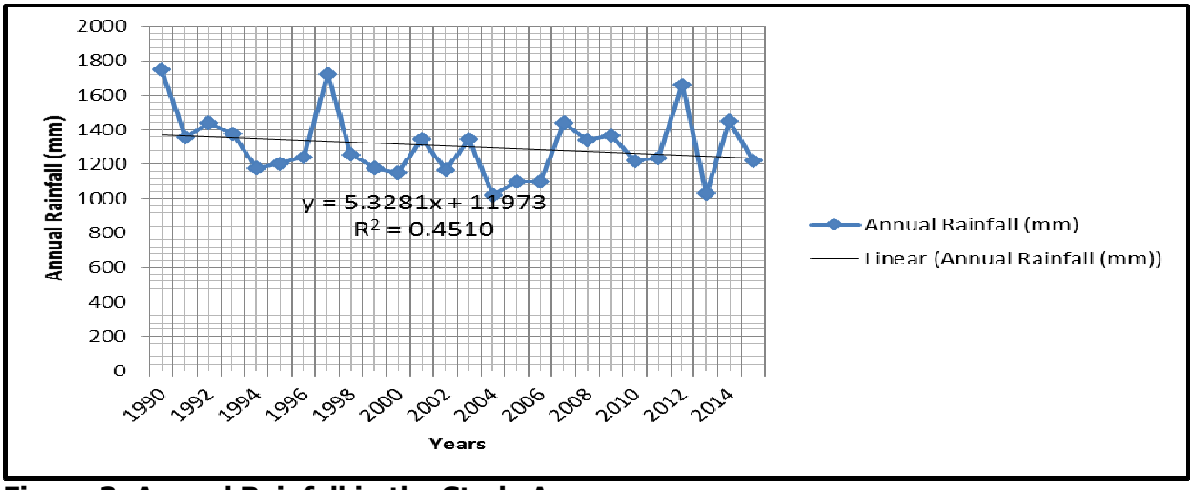

Figure 3: Annual Rainfall in the Study Area
Source: Authors Data Analysis, 2016

Considering the mean annual rainfall of about 1303.6mm in 26years (1990 to 2015), from 1990 to 1993, 1997, 2001, 2003, 2007 to 2009, 2012 and 2014 has annual rainfall data above the mean; while the remaining 14 years revealed annual rainfall below the average which indicate that annual rainfall is decreasing despite some fluctuation. This shows that annual rainfall is decreasing which has affected Shiroro dam through its inflow and outflow negatively.

R-square (R^2), or the square of the correlation coefficient, is a fraction between 0.0 and 1.0. A R^2 value of 0.0 means that there is no any correlation between X and Y and no linear relationship exist between X and Y. On the other hand, when R^2 approaches 1.0, the correlation becomes strong and with a value of 1.0 all points lie on a straight line. R^2 of 0.4510 shows that there is linear relationship between the annual rainfall and the years.

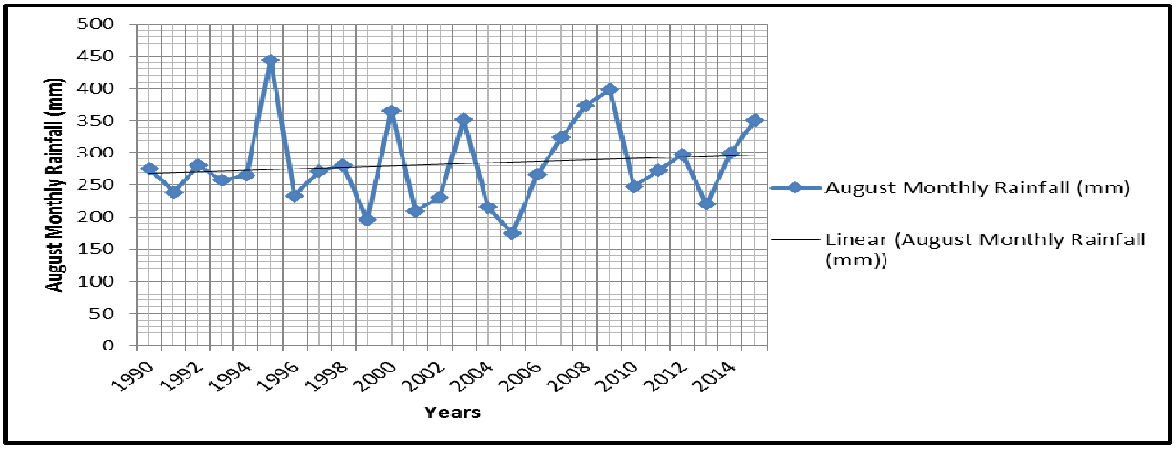

Figure 4: August Monthly Rainfall of the Study Area
Source: Authors Data Analysis, 2016

Figure 4 shows monthly rainfall of August for 26 years (1990 to 2015) and the monthly rainfall tends to be increasing from 174.1mm in 2005 to 443.8mm in 1995. This has translated to more flooding activities in the study area due rise in inflow and outflow data. Recently, month of August for the years 2012, 2014 and 2015 has high monthly rainfall and

the people in the study area confirmed that it resulted in more flooding activities which has effected both infrastructure, farm produce and lives of the inhabitant living in the area.

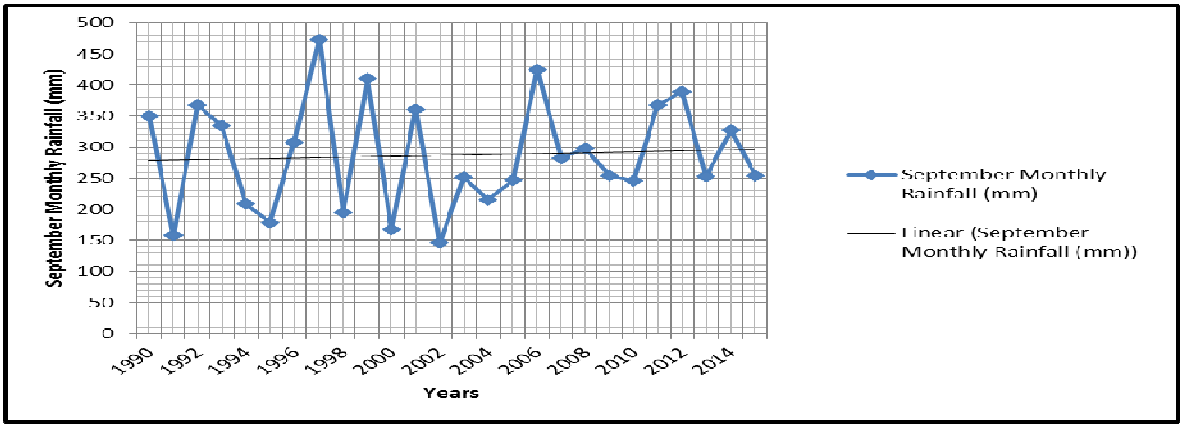

Figure 5: September Rainfall in the Study Area
Source: Authors Data Analysis, 2016

Considering the monthly average of 287.2mm from Figure 5 which was derived from linear trendline, 12 years have monthly rainfall above average and the years include 1990, 1993 to 1994, 1997 to 1998, 2000, 2002, 2007 to 2008, 2011 to 2012 and 2014. This shows that more flooding were likely to be recorded in those months of the years with higher magnitude due to the magnitude of inflow in to Shiroro dam. The remaining years like 1991, 1994 to 1995 have less magnitude considering both the total volume of rainfall in September and the daily rainfall record. This finding was in line with the finding of Inflow analysis of the study.

The hydrologic variables considered in this study include Inflow and Outflow. As indicated in Figure 6, the mean monthly Inflow has the highest value in the month of September with 1045m^3/sec and the lowest was in the month of April with the value of 29.03m^3/sec.

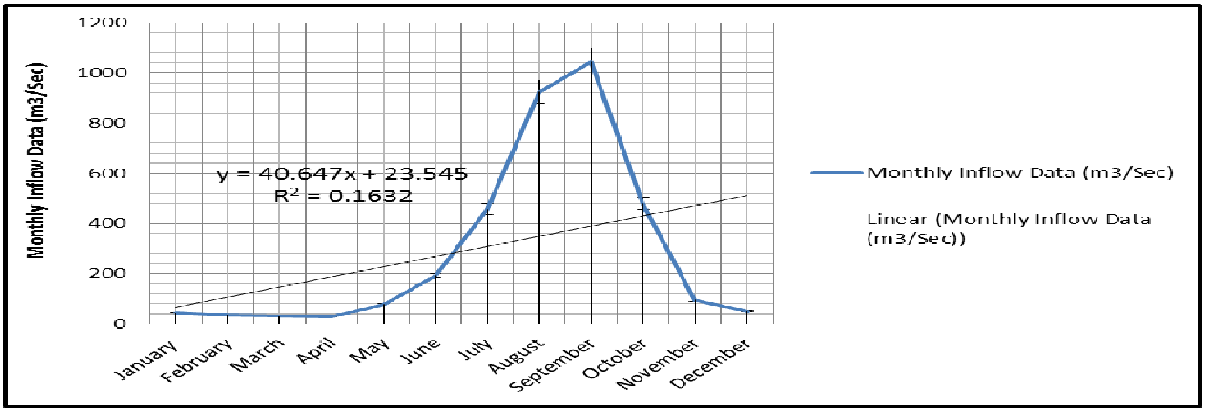

Figure 6: Monthly Inflow of Shiroro Dam
Source: Authors Data Analysis, 2016

The monthly Inflow started increasing from May with 78.72m^3 and got to its peak in the month of September with 1123.48m^3, then started decreasing as rainfall decreased from 506.4m^3 in November to 26.68m^3 in April. R^2 of 0.1632 shows that there is linear relationship between the monthly Inflow and the monthly rainfall and this relationship comes to play as monthly Inflow increases. As indicated in Figure 6, the Linear Forecast Trendline shows that

mean monthly inflow will continue to increase as long as rainfall increases along River Kaduna and evaporation decreases.

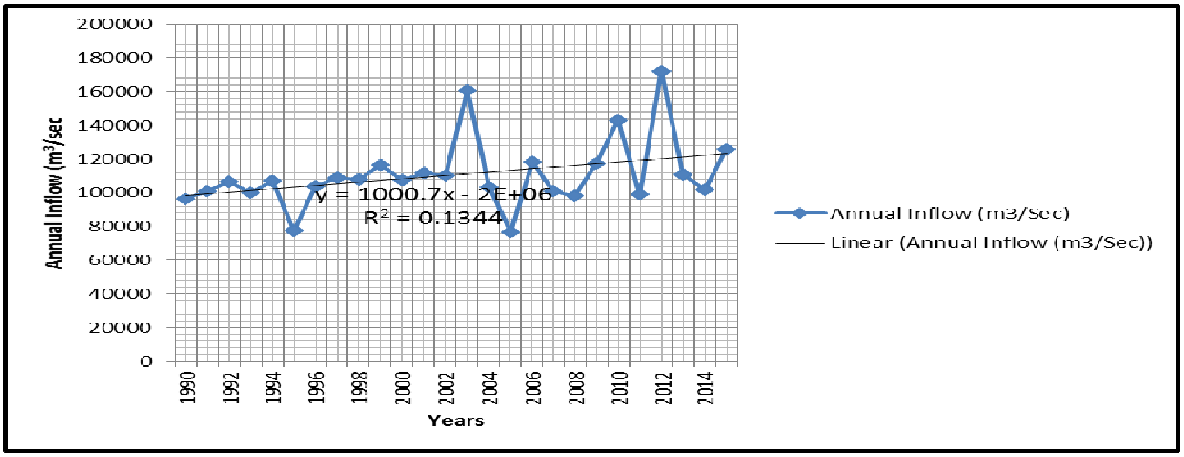

Figure 7: Annual Inflow of the Study Area
Source: Authors Data Analysis, 2016

Figure 7 shows that annual inflow has been increasing despite some fluctuation in some years. Year 2012 has the highest annual inflow with 171839m^3/sec while 2005 has the lowest annual inflow (76897m^3/sec). From Figure 7, mean annual Inflow was 110931m^3/sec and this shows that 8 years which include 1991 to 1992, 1994, 1998, 2000, 2003, 2007, 2010 and 2012. R^2 of 0.1344 shows that there is linear relationship between the annual Inflow and the years and this relationship come to play as years Inflow increases.

Dam operations play an important role in the quantity of Inflow and outflow production on Shiroro dam. This is because the performances of hydrology depend on the rules guiding water intake and release. Where there is an inefficient reservoir rules water intake will be affected, and this will consequently affect outflow in the study area. Efficient operation rules for a reservoir would be difficult to design without knowing the relative importance or the contribution of individual hydrology elements like inflow and outflow; especially on monthly basis.

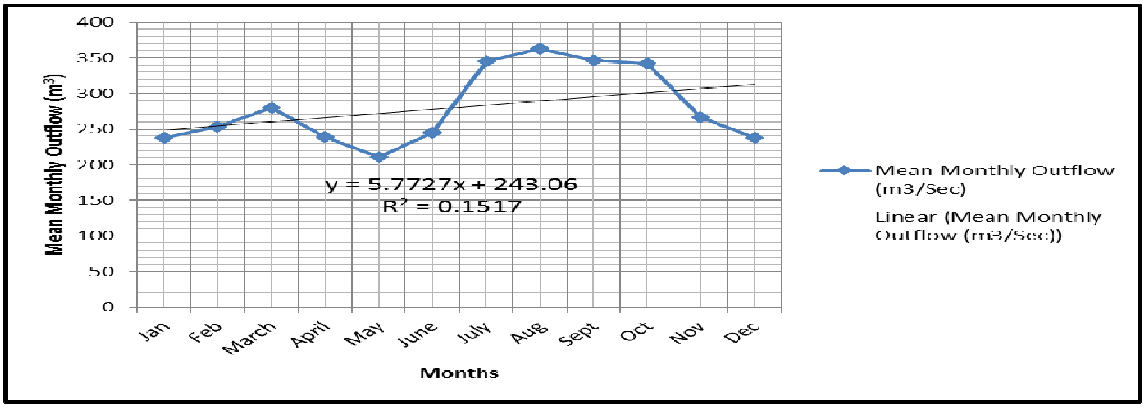

Figure 8: Monthly Outflow of Shiroro Dam
Source: Authors Data Analysis, 2016
The mean monthly outflow of Shiroro dam has its peak in the month of August with a value of 351m^3/sec and the lowest was in the month of May with 211m^3/sec. This shows that mean monthly Outflow follows the pattern of monthly rainfall and monthly Inflow of Shiroro dam. This also shows that flooding phenomena was more active in the months of July to September from the findings.

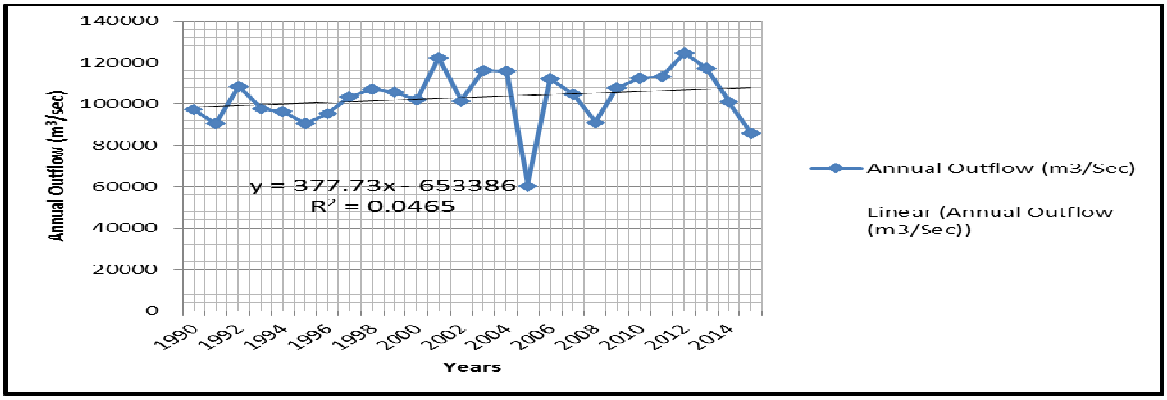

Figure 9: Annual Outflow of Shiroro Dam
Source: Authors Data Analysis, 2016

Annual outflow of Shiroro dam have been increasing since 1990 despite some fluctuation and the peak outflow was in year 2012 with a value of 124472m^3/sec; while the lowest value was in the year 2005 with a value of 60135m^3/sec. This highest outflow which was in 2012 correspond to one of the worst flood in the history of the study area. Shiroro reservoir inflow which is being closely monitored has recorded a few surges since May in response to the prevailing hydrological trends and events on the basin as confirmed by instrumental records. For instance an unusually high average daily inflow magnitude of 1389m^3/sec was recorded on the 31st May 2012. Similarly, another high inflow value of 2004m^3/sec was recorded on the 18th of August. All other records up to the 9th September were generally around 1000m^3/sec. Furthermore, inflow from 9th September have been high but quite normal and generally above 2000m^3/sec with a peak of 2406m^3/sec on the 13th.

However, this trend suddenly changed on the 16th September as a flash flood induced by prolonged heavy downpour lasting more than 48hours from within the immediate vicinity of the reservoir and adjacent basins pushed inflow to unprecedented levels. As a result of the long duration and high-intense rainfall which measured up to 120mm at Shiroro, inflow sharply increased from the 2026m^3/sec of 15th to an extraordinary and unprecedented magnitude of 4000m^3/sec *(average)* on the 16th leading to extra rapid reservoir filling. Reservoir operation for flood management and reservoir control which was embarked upon immediately thus became very hectic and unavoidable. The need to keep the reservoir at safe and steady state therefore necessitated the release of large volumes of water through the spillway gates.

Table 2: ANOVA for Annual Rainfall and Annual Outflow

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	454652620.301	1	454652620.301	1.045	.317[b]
	Residual	10440527592.315	24	435021983.013		
	Total	10895180212.615	25			

a. Dependent Variable: Annual Inflow (m^3/Sec)
b. Predictors: (Constant), Annual Rainfall (mm)
Source: Authors Data Analysis, 2016

From the table of the F-distribution, critical value of F at 0.05 = 4.26 since the calculated F of 1.04 < 4.26, thus, there is a significant linear relationship between annual rainfall and annual Inflow of Shiroro dam.

Table 3: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change
1	.204[a]	.052	.002	20857.181	.052

Source: Authors Data Analysis, 2016

As indicated in Table 3, R^2 was 0.52 for annual rainfall, thus, rainfall account for 52.0% of the explained variance between annual rainfall and annual Inflow in the study area. This shows that other climatic variables like temperature and relative humidity also play important role in Inflow data since there is remaining 48%.

Conclusion

As indicated in the findings of this study, it shows that rainfall, inflow and outflow are the major players in trend of flood events in the study area. The results shows that August and September monthly rainfall couple with inflow and outflow of the stated months are the controller of flood events in the study area which in turn has affected the environment and socio-economic activities of the riparian communities negatively. This study confirmed that any significant increase in monthly rainfall will lead to inflow, outflow and subsequently flood events across the riparian communities of Shiroro dam, Niger State. It's therefore recommended that town planners as well as NSEMA specify habitable and non-habitable area in riparian communities of Shiroro dam so as to avoid the flood hazard from affecting the lives and properties of the people.

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ARTICLES AND RESEARCH REPORTS ON TECHNOLOGY

IMPACT OF DATA PROCESSING MODE ON INVENTORY MANAGEMENT SYSTEM IN THE NIGERIAN BREWERY INDUSTRY

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Abstract
This study examined the impact of data processing mode on inventory management system in the Nigerian Brewery industry. Primary data were sourced through the administration of questionnaire to 100 respondents in the Nigerian Brewery industry. The population for the study comprises all members of staff of brewery companies quoted on the Nigerian Stock Exchange. Purposive sampling technique was used in selecting the three leading brewery companies in Nigeria. They represent 75% of the breweries quoted in the Nigerian Stock Exchange facts book namely the Nigerian Breweries Plc; Guinness Nigeria Plc; and International Breweries Plc. Purposive sampling was also used in selecting members of staff in the companies who are in management and technical categories in charge of inventory management. The data collected were analyzed using descriptive (tables and percentages) and inferential statistics (chi-square). The results showed that the batch processing representing 47.3% of the respondents is the commonest processing mode being used in the inventory management of most firms in the Nigerian brewery industry and also revealed that data processing mode has positive effects on performance, effectiveness and effectiveness of inventory management system. Based on this finding, the study concluded that batch data processing mode is the predominant processing mode and that appropriate data processing mode should be deployed for inventory management system in the Nigerian Brewery industry.

Keywords: Inventory, Data processing mode, ICT, Data processing, Inventory Management System

Introduction

The introduction of information and communications technology (ICT) has not only made reporting of events to be done at a fast speed as if the whole world is a small village through the use of internet but has also aided virtually all sectors of human endeavours. Mathur (2010) submitted that inventories are major determinant of the revenues of most business outfits. These inventories may comprise raw materials, work-in-progress, spare parts/consumables, and finished goods. It is not compulsory that a business outfit has all these inventory classes. Nonetheless, whatsoever may be the inventory items; they need well-organized management this is because generally a substantial portion of its capitals is invested in these inventories (Vohra, 2008).

Kanaracus (2008) said despite the fact that there was economic meltdown in 2008 which affected many businesses adversely all over the world, it was discovered that organizations kept on increasing their expenditures on the deployment of information and communications technology (ICT) systems in their operations which invariably increases their budgets but Petter, Delone and McLean (2008) were quick to react that firms only concentrate on unfolding, applying and assessing utilitarian ICT systems in their operations so as to achieve organizational goal and objectives.

Meanwhile inventory management could be regarded as the life-blood and backbone of any successful manufacturing setting. It refers to appropriate methods or techniques to manage raw materials, work-in-progress as well as finished goods to minimize cost in a bid to achieve the set organizational goals and objectives while Inventory are resources of an organization that are being kept by the organization for future use (Donald, 2013). Robert and Richard (2013) posit that inventory normally denotes physical goods to be traded and the materials needed to manage the service of a business. To Robert and Richard, there are two key purposes of inventory control, whether you are dealing with manufacturing, distribution, retail, or services, is to specify (i) when to order for the items as well as (ii) how big the order should be i.e. the size of the order.

Chowdhury (2000) described ICT as technologies that can process diverse kinds of information (video, text, audio and data), and make possible different forms of communications among human agents as well as information systems. Musa (2013) contended that information and communications technology (ICT) is a generic term that comprises of all advanced technologies in manipulating and communicating information. Obasan (2011) posited that the deployment of ICT in business organizations has considerately improved operations and performance of businesses in Nigeria.

Olawale (2014) in Breweries Sector Report 2014 posited that Africa has an end user market of over one billion people of beer consumption, average Gross Domestic Product growth of 5% up to 2020 and a beer consumption per capita of 9 liters (vs.25liter peer average),the growth of beer market in the continent of Africa is without doubt credible. Also, Olawale (2014) said that all eyes are on Nigeria as far as beer consumption is concerned being a heavily populated nation and largest (still growing) economy in Africa, with considerable latent for a double digit growth. The Nigerian brewery industry is not completely left to mainly Nigerian investors as leading international players like Heineken N.V controls 70% of Nigerian beer market with majority stake in Nigerian Breweries Plc and Champion Breweries Plc while Diageo controls 27% through its ownership of Guinness Nigeria Plc and SABMiller controls 3% through its stake in International breweries Plc and Pabod breweries Ltd.

Statement of the Problem

The brewery industry has many stocks to contend with, that is raw materials of different types, work-in-progress of varying degrees as well as finished products of different brands. So to monitor the levels of these varying categories of stock items physically has been discovered to be herculean task as this will be proned to human errors.

For instance, the National Agency for Food and Drug Administration and Control (NAFDAC) slammed a fine of N1 billion administrative charges on Guinness Nigeria Plc for its failure to adhere to the recommended good manufacturing practice procedures. It was learnt that the Enforcement Department of the agency had conducted a routine check on the company's factory in Ikeja, Lagos on November 5, 2015 where shocking revelations were made. The NAFDAC team came back with unsatisfactory appraisals about how some of the materials used in the production processes were being stored.

Even though there have been numerous studies (for example, Itod, Maji and Abdu (2010), Mathur (2010), and Ogbo, Onekanma, and Wilfred (2014) on the impact of inventory management on organizational performance much has not been done on the effect of ICT on inventory management *vice –a-vise* the data processing mode of the system most especially in the brewery industry. It will be recalled that an Enterprise Resource Planning(ERP) was designed to provide benefits of instantaneous capabilities and flawless communication for business in large organizations. There were very few studies to

corroborate the fact that the processing mode is real-time and that was why Davenport (1998) opined that due to the fast range of potentials and the well-presented statements of things that will definitely happen made by vendors, expectations of Enterprise Resource Planning (ERP) packages are high and that the promise of a standardized (off-the-shelf) solution to business integration troubles seems very alluring. In a nutshell, there is a sort of ambiguity with respect to the data processing mode of an inventory management system being deployed by breweries in Nigeria for their inventory.

Purpose of the Study

The purpose of this study is to examine the impact of the data processing mode(s) on inventory management system in the Nigerian Brewery industry.

Research Questions

What are the data processing modes of inventory management system in the industry?
What is the effect of data processing mode on performance of inventory management system of firms in the industry?

Does data processing mode impact on effectiveness and efficiency of the inventory management system?

Objectives of the Study

(i) Investigate data processing modes of inventory management system being deployed in the Nigeria Brewery Industry;
(ii) Examine the effect of data processing mode on inventory management system being deployed in the Nigeria Brewery Industry; and
(iii) Analyze the impact of data processing mode on effectiveness and efficiency of the inventory management system being deployed in the Nigeria Brewery Industry.

Hypotheses for the Study

Hypotheses for this paper were in null form. They are as follows:

(i) **Ho_1**: Data processing mode of an ICT driven inventory management will not improve performance of inventory management of firms in the Nigerian Brewery Industry.
(ii) **Ho_2**: Effectiveness and efficiency of an inventory management system does not depend on its data processing mode.

Methodology/Materials or Methods

Primary data were utilized for this study. The primary data were sourced through administration of questionnaire. The population for the study comprises all members of staff of brewery companies quoted on the Nigerian Stock Exchange. Purposive sampling technique was used in selecting the three leading brewery companies in Nigeria. They represent 75% of the breweries quoted in the Nigerian Stock Exchange factsbook namely the Nigerian Breweries Plc; Guinness Nigeria Plc; and International Breweries Plc. Purposive sampling was used in selecting members of staff in the companies who are in management and technical categories in charge of inventory management. These include Nigerian Breweries Plc (45); Guinness Nigeria Plc (35); and International Breweries Plc (20) totaling 100. Data on variables such as data processing mode, and impact of data processing mode on effectiveness, performance and efficiency of inventory management was sourced from the selected staff. Data collected were analyzed using appropriate statistics.

Literature Review
Historical Development

Inventory
It is very conspicuous that inventories occupy the greatest strategic place in the arrangement of working capital of most commercial enterprises and firms in the brewery industry are not an exception. Inventories constitute the major component of current asset in most business enterprises. In the scope of working capital, the effective control of inventory has posed the most grave problem to the firms in the brewery industry because about two-third of the current assets of firms in the industry are being seized in inventories. The revenue from inventory is a principal determinant of the turnover of working capital of business organizations and the firms in the Nigerian brewery are not an exception. It is therefore quite expected that inventory which helps in making the most of turnover occupies the most substantial place among current assets (Mathur, 2010).

Importance of Inventory Management
The primary objectives of inventory management according to Mathur (2010), are: to reduce as much possible funds investment in inventories and to minimize the probability of disruption in the manufacturing plan of a firm for lack of raw material, stock and spare parts. So it is crucial to have indispensable inventories and at the same time avoid excessive inventory because it constitute an unused resource to the organization. Therefore, investment in inventories should be just adequate in the optimal level. The author also submitted that the major dangers of excessive inventories are: excessive carrying cost, the risk of liquidity and the avoidable tie up of the organization's capitals and loss of profit. Mathur (2010) also opined that a successful inventory management should among others thing regulate investment in inventories and keep it at an optimal level, safeguard the inventory against decline, obsolescence and unapproved use, reduce the carrying cost and time, preserve adequate stock of raw material in time of short supply and expected price changes, minimize investment in inventories, ensure that finished goods are available for onward delivery to customers in a bid to fulfill orders, unhindered sales operation and efficient customer service, ensure that materials are available for use in manufacturing and production services as and when needed, ensure a constant supply of material to production department thereby enabling continuous production, and keep satisfactory stock of finished goods for unhindered sales operations.

Types of Inventory
Ile (2002) submitted that inventory can be classified into three types. These are: Raw Materials inventory (these are items purchased by a business for processing like water, malt, mash, yeast among others are some of the raw materials inventories that a company in the brewery industry may require for its production processes), Work-in-progress inventory (this is also known as goods-in-progress inventory- a middle stage of raw material inventory that is yet to be completed by the manufacturing plant to enter into another stage of production) and Finished goods inventory (it comprises of stock of finished goods - these could be stock of goods pending shipment or in the storeroom. Donald (2013) listed Spare parts, for machinery, equipment, among others and Consumables such as oil, paper, fuel among others.

Zengwa and Choga (2016), did a study on the Role of Information and Communications Technology (ICT) in Company Inventory Management in Zimbabwe: 2011-2013. The study discovered that the adoption of information and communications technology (ICT) has been dispersing rapidly in inventory management throughout the last few decades as businesses seek to improve efficiency through increased incorporation among suppliers and buyers but

was silent on the data processing mode of the inventory management system being deployed despite the fact that the study revealed that the companies studied had adopted an Enterprise Resource Planning (ERP) for their inventory management to improve transaction processes and sustained information sharing among different system users but some modifications were required to attain an well-organized and effective inventory management system.

Historical Development of Inventory Management System

The first initiative towards automation of the inventory management was spearheaded by the foremost world leading computer manufacturer; International Business Machine (IBM) when it introduced an inventory package called IMPACT (an acronym for Inventory Management Programme And Control Techniques) for the wholesale and retail trade (IBM, 1967). IBM's inventory package; IMPACT was criticized for common sense accompanied by mathematical solutions for simplified forms which involves so many exceptions and limitations that it is quite complex to gain insight into the fundamentals i.e. not being based on truly optimum set of rules but on heuristic (Kleijnen, 1978). The pioneering effort and initiative from IBM were an eye opener for other computer manufacturers as they followed with similar systems or other products that could offer a better deal.

Another computer manufacturer; International Computers Limited of London (ICL) also introduced its own system or product called SCAN aiming at assisting managers in inventory management (ICL, 1970). Siemens, another computer giant developed its system called HOREST (Siemens, 1970). It was designed and programmed to aid inventory management. During the 1980s, several inventory decision support systems were developed. Kiran and Loewenthal (1985) developed a system called an Integrated Decision System for Inventory Management (IDSIM) which is a microcomputer based decision support system. The new IDSIM entails a main program which interacts with six other well-designed subroutines that are clear as crystal to the user. This new system can be used to make decisions on inventory control variables such as order quantities, safety stocks and order points, at both the individual item and aggregate levels. The most current version of IDSIM is written in an interactive manner in order to facilitate its operation in the decision making process of an organization and allows the user of the software to alert the data and constraints and to do complex analyses at various points during the program execution.

Moras (1989) also developed another system called MICROLOT (Inventory Control System on the Microcomputer) and the program was written in BASIC language (Beginners All Purpose Symbolic Instruction Code), and runs on IBM and compatible microcomputers. It implements a decision support system for single-item stock problems with deterministic and stochastic demand distributions. MICROLOT features a friendly user interface and graphical aids. The deterministic case includes systems with constant (linear) demand and systems with time-varying demand. Periodic appraisal (order-up-to-level) and continuous review (order point) systems are addressed in the stochastic case. The most recent according to another author, Rouse (2015) is an Enterprise resource planning (ERP) is a category of business management software (an ICT powered inventory management system) which is usually a collection of integrated applications, that enables a business to collect, store, manage and deduce data from many business actions. These business activities or actions includes planning of product, cost, manufacturing or service delivery, marketing and sales, inventory management, shipping and payment.

Information and Communications Technology (ICT)

Information is the bone of today's business organizations, institutions and industries (Musa, 2013). To Musa, information and communication technology (ICT) cover all highly developed

technologies in manipulating and communicating information. Musa (2013) thereafter identified three core components of information and communications technology. These core components are information; the use of computers to process data into information, communications; communication of information through networks while technology; the technical know-how used for the transmission and this will determine the degree to which a firm makes use of information and communications technology towards accomplishing the organizational objectives.

Information and communications technologies (ICTs) play a significant role in the process of providing effective and efficient services, products and packages in order to better satisfy their customers in several service providing businesses, organizations and manufacturing firms (including the firms operating in the Nigerian brewery industry) worldwide. Corporations face a predicament in today's competitive marketplace, where on one hand, clienteles demand personalized products and services and want that their orders are filled speedily, however they do not want to pay a premium (an additional cost) for this customization and availability (Graman and Magazine, 2006).

Data Processing Mode and Inventory Management System

Even though there have been numerous studies about the impact of inventory management on organizational performance much has not been done on the effect of ICT on inventory management vice –a-vise the data processing mode of the system most especially in the brewery industry. Recalled that the well known data processing modes are Off line, On line, Real-Time, Time Sharing, Batch processing, Multiprogramming and Multiprocessing. Each has its own features, advantages and disadvantages which are taken into consideration before it is selected for an operation. It will be recalled that an ERP system was designed to provide benefits of instantaneous capabilities and flawless communication for business in large organizations. There are very few studies to corroborate the fact that the processing mode is real-time and that was why Davenport (1998) opined that due to the fast range of potentials and the well-presented statements of things that will definitely happen made by vendors, expectations of ERP packages are high and that the promise of a standardized (off-the-shelf) solution to business integration troubles seems very alluring. Implying that these features may not be obtainable when the ERP system is bought and deployed in business operations. Data is collected, entered, processed and then the batch results are produced. In a batch processing system, transactions are accumulated over a period of time and processed as a single unit, or batch. Whatever the time period in a batch system, there is some time delay between the actual event and the processing of the transaction to update the records of the organization.

Inventory management systems deployed by business organizations were deployed to automate day after day inventory related transactions in order to reduce costs and human error during data entry operations. Cheng & Chou (2007) and Swamidass (2007) submitted that previous empirical studies have also shown that deployment of ICT driven inventory management systems with appropriate data processing mode had not only help in safeguarding the service level but also reduces amount of inventory costs, which can be invested in other profitable business investments. In fact, these authors were emphatic when they submitted that there exists a close relationships between ICT implementation and inventory management performance and that real-time inventory decision support system has not only reduces the inventory costs but also assists in maintaining the service level greater than 90% for various demand patterns. Also, Yu & Ramanathan (2008) studied ICT adoption in UK firms and found out that businesses that had installed high technology in ICT achieved significant operational efficiency.

Deployment and implementation of Information and communications technology via the use of an appropriate data processing mode for inventory management operates as a tool for enhancing efficiency, economies of scale and cost reduction. Organizations are striving to achieve these trios in today's highly competitive business environment. It could not be out of order to say that ICT has been adopted in inventory management processes by business organizations as a competitive edge and to build strategic long term relationships along the supply chain.

Theoretical Framework

The resource-based view (RBV) is a model that sees resources as key to superior firm performance and that if a resource is valuable, rare, costly to imitate and can be organized (represented with acronym VRIO) to capture value attributes, the resource will enables the firm to gain and sustain competitive advantage. That is to say the company will have to subject the resource to VRIO structure (is the tool used to analyze a firm's internal resources and capabilities to find out if they can be a source of sustained competitive advantage) (Rothaermel, 2012, Barney, 1991).

This study was anchored on the resource-based theory because firms or companies in the Nigerian brewery industry have huge amount of inventory items that are germane to the manufacturing of various categories of products with heterogeneous resources that differ from one brewery to another. These features justify the adoption of this theory for this study. In this case, the firms in the brewery industry may see information and communications technology as a resource that should be deployed in a unique way for the organization to gain competitive advantage over others in the Nigerian beer market that has latent for double digit growth and this is in line with the submission of Bharadwaj (2000), who contend that the resource-based view (RBV) theory argues that ICT may be viewed as a resource and that organizations may choose to invest in ICT resources that are rare, inimitable, and non-substitutable.

Conceptual Scheme /Model

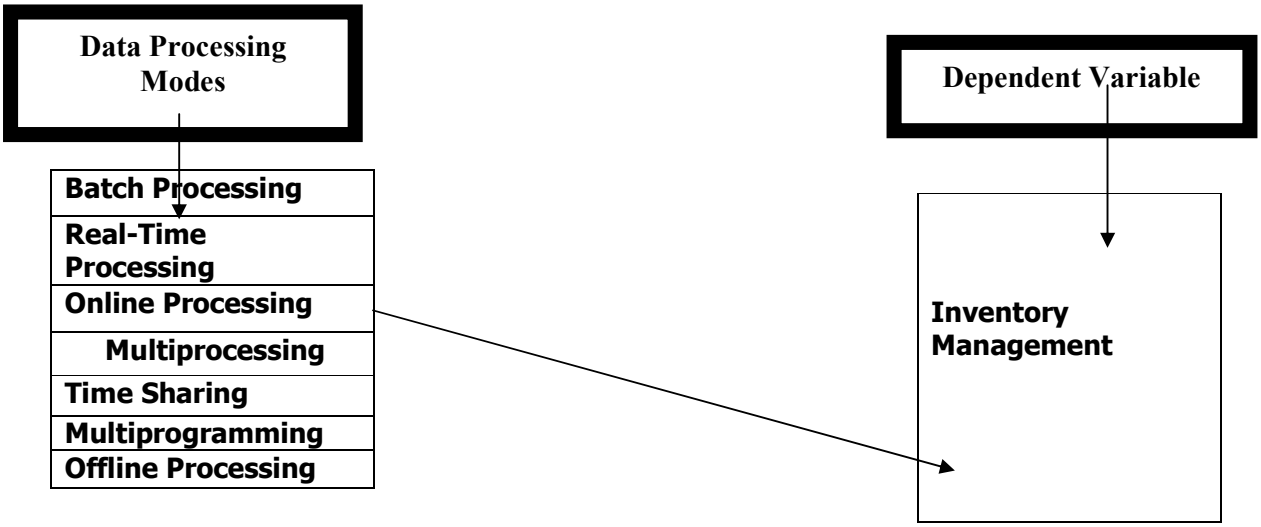

Fig. 1.1: Schematic Diagram showing the relationship between Data Processing Mode and Inventory Management. Source: Author, 2016

Results and Discussion

The processing mode of inventory management system employed in the Nigerian brewery industry as suggested by the respondents with the percentage of respondents each mode included: batch processing (47.3%), multiprocessing (20.2%), time sharing (18.0%), multiprogramming (9.0%), online (2.2%), real-time (2.2%), and offline (1.1%). This implied that batch processing is the major data processing mode of inventory management system employed in the Nigerian Brewery industry.

Table 1: The data processing mode of inventory management system employed in the Nigerian Brewery industry

Data Processing Mode	Percentage of Respondents (N= 89) (%)
Batch Processing	47.3
Multiprocessing	20.2
Time Sharing	18.0
Multiprogramming	9.0
Real-Time	2.2
Online	2.2
Offline	1.1

Source: Filed Survey, 2016

Testing of Hypotheses

For Hypothesis I: Inventory management performance is not a function of data processing mode of firms in the Nigerian Brewery Industry. Respondents were asked if they strongly agree, agree, undecided, disagree or strongly disagree with the notion that data processing mode of their inventory management systems reduces production breakdown, aids reduction in production costs, leads to reduction in delivery time, enhances forecasting and planning, speeds up inventory management processes, reduces paperwork, enhances better flow of information and reduces inventory cycle time. Their responses were presented in table 2.

Table 2: Effect of Data processing mode on performance of inventory management system

Options	Frequency
Strongly Agree	60
Agree	20
Undecided	4
Disagree	3
Strongly Disagree	2
Total	89

Source: Filed Survey, 2016

Testing of the hypothesis

Using $\chi^2 = \frac{\xi(\text{Observed frequency - expected frequency})^2}{\text{Expected frequency}}$

Expected frequency = $\frac{60 + 20 + 4 + 3 + 2}{5} = \frac{89}{5} = 17.8$

Table 3: Chi-square Table

Responses	Observed (O)	Expected (E)	O -E	$(O-E)^2$	$\frac{(O-E)2}{E}$
Strongly Agreed	60	17.8	42.2	1780.84	100.05
Agree	20	17.8	2.2	4.84	0.27
Undecided	4	17.8	-13.8	190.44	10.70
Disagreed	3	17.8	-14.8	219.04	12.31
Strongly Disagreed	2	17.8	-15.8	249.64	14.02
Total	89				**137.8**

Calculated χ^2 is 137.8 while the χ^2 from the table is obtained by assuming 5% level of significance and using M = N - 1 for degree of freedom, where N is the number of row of the table for the chi-square. Here, N is 5, therefore degree of freedom (M) = 5-1 =4. Therefore, the χ^2 from the chi-square table is 9.488. Since the computed χ^2; 137.8 is greater than 9.488, we therefore reject the null hypothesis (H_0) and accept the alternate hypothesis (H_1). That is to say, we conclude that Inventory management performance is a function of data processing mode of inventory management system of firms in the Nigerian Brewery Industry.

For Hypothesis II: Effectiveness and efficiency of an inventory management system does not depend on the data processing mode of firms in the Nigerian Brewery Industry. Respondents were asked if they strongly agree, agree, undecided, disagree or strongly disagree with the notion that data processing mode of their inventory management systems helps to remove market barriers, enhances processing of orders, helps in streamling supply chain by removing inefficient intermediaries and conclusively improving the effectiveness and efficiency of the inventory management processes. Their responses were presented in table 4.

Table 4: Effect of Data processing mode on the effectiveness and efficiency of the inventory management processes

Options	Frequency
Strongly Agree	65
Agree	15
Undecided	4
Disagree	2
Strongly Disagree	3
Total	89

Source: Filed Survey, 2016

Testing of the hypothesis

Using $\chi^2 = \frac{\xi(\text{Observed frequency - expected frequency})^2}{\text{Expected frequency}}$

Expected frequency = $\frac{65 +15+4+2+3}{5} = \frac{89}{5} = 17.8$

Table 4: Chisquare Table

Responses	Observed (O)	Expected (E)	O -E	$(O-E)^2$	$\frac{(O-E)2}{E}$
Strongly Agreed	65	17.8	47.2	2227.84	125.16
Agree	15	17.8	-2.8	7.84	0.44
Undecided	4	17.8	-13.8	190.44	10.70
Disagreed	2	17.8	-15.8	249.64	14.02
Strongly Disagreed	3	17.8	-14.8	219.04	12.31
					163.07

Calculated χ^2 is 162.629 while the χ^2 from the table is obtained by assuming 5% level of significance and using M = N - 1 for degree of freedom, where N is the number of row of the table for the chi-square. Here, N is 5, therefore degree of freedom (M) = 5-1 =4. Therefore, the χ^2 from the chi-square table is 9.488. Since the computed χ^2; 162.629 is greater than 9.488, we therefore reject the null hypothesis (H_0) and accept the alternate hypothesis (H_1). That is to say, we conclude that effectiveness and efficiency of an inventory management system depend on the data processing mode of firms in the Nigerian Brewery Industry.

Discussion

From the research conducted it was discovered that the most predominant data processing mode of the inventory management system being employed by breweries in Nigeria is Batch Processing. Batch processing from the study has a percentage of 47.3 compared to other processing modes identified in this study. The finding reveals what operates in the Nigerian Brewery Industry where there are huge volumes of inventories as a result of multiple product lines. This finding buttressed the fact that Nigeria's economy is still developing because full version of the Enterprise Resource Planning system has not been deployed in some segments of the economy. The study also revealed that data processing mode of inventory management system had positive effects on the performance of the of inventory management of firms in the Nigerian brewery industry. It was also discovered that data processing mode of inventory management system had positive effect on the effectiveness and efficiency of inventory management system of firms in the Nigerian Brewery industry from inventory. These findings are in agreement with the findings of previous studies of Yu and Ramanathan (2008), Cheng and Chou (2007) and Swamidass (2007) but not in line with the findings of Nah, Lau, and Kuang, (2001) and Soh, Kien, and Tay-Yap (2000). The two studies opined that Enterprise Resource Planning (ERP) system produce and access information in a real-time environment to facilitate rapid and better decisions and cost reductions that will eventually pave way for improved performance of the firms, efficient and effective inventory management and increase profitability from inventory.

Conclusion and Recommendation

This study examined impact of the data processing mode on the inventory management system in the Nigerian Brewery industry through the administration of questionnaire and the responses were analyzed using descriptive and inferential statistics. It concluded that batch data processing mode is the predominant in the industry, that data processing mode of inventory management system had positive effects on the performance as well as the effectiveness and efficiency of the of inventory management and that data processing mode of inventory management system had positive effect on profitability of firms in the Nigerian Brewery industry from inventory. It is recommended that Breweries in Nigeria should

deployed full version of enterprise resource planning system or a comparable Nigerian made system to enable the firms take the advantages of a real-time system.

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A SEAMLESS QUERY APPROACH TO MULTIPLE DATABASES

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Abstract
The maturity of Internet has given rises to many e-commerce sites that users may need to access. Therefore, there is need to provide users with easy and flexible access to information from multiple, dispersed and heterogeneous e-commerce data sources via single point of access. E-commerce sites are continuously emerging, maintained by different organizations and managed independently. The combination of data from different e-commerce sites on the internet usually fails due to syntactic and semantic differences. The access, retrieval and utilization of information from the different e-commerce web portal necessitate the need for easy and seamless access to several databases. Semantic difference technically refers to as semantic heterogeneity is a major issue that needs to be resolve in order to create interoperability among several databases on the internet. Though, there are existing approaches, but they are no longer efficient in the current reality of ubiquitous data on the internet. In this paper, an architecture for unify interface to multiple data sources on the internet is proposed. The paper adopts ontology-based approach using WordNet as a semantic dictionary for the reconciliation of semantic conflicts between the concepts or terms. Experimental evaluation of the proposed approach shows that the synonyms of a queried term are generated as hit from the available databases, which implies the feasibility and effectiveness of the approach.

Keywords: Ontology, WordNet, Query Reformulation, Multiple Databases

Introduction

The revolution in the 21st century has made Internet an alternative medium for the exchange of goods and services. One aspect of human survival that is becoming dependent on the Internet is commerce. Internet enabled commerce popularly known as e-commerce is the act of selling goods online using computers or devices that allow online transactions.

As e-commerce is widely embraced and computer is becoming more affordable, databases become more widely used. Exchange of data between multiple and heterogeneous distributed databases become necessary, and consequently database interoperability and integration have been an open research area. The e-commerce domain has necessitated a new requirement for information services that are homogenous in their presentation, open in terms of software architecture and a global scope (Antoniou & Harmelen, 2008). There is need to support smooth interaction within the different, independent, distributed data sources of same domain running on heterogeneous platforms.

To address this issue, several schemes were developed; global schema approach (Asfari, Doan, & Sansonnet, 2009), which defines a global schema over the component database systems that capture the union of the information content of the component schemas, Federated database approach (Ghawi & Cullot, 2009), which exports schemas of distributed database and integrates with the local schema to provide the necessary views for the local users and Ontology-based approach (Sharma & Gulati, 2010), which provides explicit specification for entities and ontology languages for querying the different data sources.

Each of the schemes is tailored toward addressing a specific challenge in multi-database system. While global schema and federated database approaches focuses on syntactic issues, ontology based focus on semantics. Ontology which is a formal and explicit specification of a shared conceptualization, Gruber (2009), will play a crucial role in describing the contents of different data sources and facilitating their interoperability. However, technology evolution is rapidly growing, the use of global ontology and the require conformity from different data sources to that ontology as currently the case, is no longer efficient in a real multi-database environment.

This research presents a different approach to query multiple databases using ontology. The paper assumed different relational databases of same domain; storing semantically related information in syntactically different terms, unlike the existing ontology approach, there is no need for conformity to a particular ontology, but only a sharing of terms for common elements using WordNet.

This paper presented an ontology-based approach for creating a unify access to multiple and disperse database in the domain of e-commerce. The developed framework provides seamless access to multiple databases without any transformation to the existing system.
A query reformulation algorithm based on WordNet synonyms is proposed for inclusion of semantically related concepts. The rest of the paper is organized as follows; Section 2 review related work and WordNet ontology. Section 3 presents the problem definition. Section 4 is the methodology and query reformulation algorithm. Section 5 presents the experimental evaluation, results and discussion, findings of the research. Lastly, conclusion and future work is in section 6.

Related Work

An emerging need to access information from different databases has resulted development of some prototypes (Ghawi & Cullot, 2009; Guarino & Giaretta, 1995; Raji Ghawi. 2010; Suwanmanee, Benslimane, Champin & Thiran, 2005). The term data integration used in association with accessing several databases in literatures is somewhat misleading; querying multiple databases might be a more appropriate term, since practically there is no integration. In literature, there are two basic types of data integration approaches (Halevy, 2001); global as view (GAV) systems and local as view (LAV) systems. Their difference lies in how the mappings are defined between the global view and the source. Though schema matching systems (Hanzala, Abid Ali & Fareed, 2008) uses semi-automatic mapping discovery between the global view and the sources, they have little or no success in constructing the global view itself. Effort is being made towards using reference ontology (Ghawi and Cullot, 2009), global ontology construction and its evolution remains an open challenge.

Data integration systems (Lenzerini, 2002) require a global view to be constructed before local sources are integrated into the system. The bottleneck in the integration process is the construction of the local ontologies for each data sources, inter-ontology mapping and mapping to global ontology. Current ontology approaches to database integration assume a well perfect ontology for each data sources and global level knowledge domain to build the integrated system. In reality, defining a perfect ontology for each database entity is not feasible, automatic ontology construction is still at infancy and integrators have limited knowledge of the data sources. Data sources must be integrated quickly and the scale of integration in reality makes defining a perfect ontology a challenge.

Using ontology for integration has been used previously in (Ghawi & Cullot, 2009; Guarino & Giaretta, 1995; Suwanmanee, Benslimane, Champin & Thiran, 2005). These systems require sources to completely commit to a particular ontology language and manually map all of their data to the ontology. Since ontologies have more powerful modeling constructs, their construction is more challenging. Inter-ontology mapping and mapping to the global ontology is a daunting task. It is still a challenge to construct a well-structured and perfect ontology for all entities in the databases and refine a global ontology.

Many researches have been done in database integration using ontology approach (Ghawi & Cullot, 2009; Guarino & Giaretta, 1995; Suwanmanee, Benslimane, Champin & Thiran, 2005). These researches assumed the databases involve to have a well-structured ontology. However, the world is dynamic hence; the feasibility of structuring a perfect ontology including the relations of all the resources in the various databases is highly impracticable.

Structuring a perfect ontology for all the databases that may be involve in data integration system is not feasible. In order to overcome the above difficulty, this paper proposed an approach of database integration that considers the databases in their original form without transforming them to conform to a particular ontology. To the best of our knowledge there is no search engine yet that has the capability to returned results according to their semantics or user intention. An interesting attempt can be trace in (Vivisimo, 2002), however; the detail of the system is not exposed.

This paper present an approach that uses WordNet as a controlled vocabulary, to discover possible semantics that the query inserted could be possibly implies.

WordNet

WordNet (Princeton, 2002) is an online lexical resource for English language that classify synonym terms into synsets, each expressing a distinct concept. The WordNet database contains information on semantic relatedness for words, including relations such as synonymy (same meaning), antonymy (opposite in meanings), hyponymy (hierarchical relationship), and meronymy (part-of relationship). WordNet labels the semantic relations among the words and provides explicit pattern other than meaning similarity, Patwardhan, and Pedersen (2006).

WordNet ontology is a good resource for mapping concepts. We extend the user query with the synonyms in WordNet belonging to the synset of each term contained in the user query. Though, WordNet contains different relations, however, we only exploit the synonyms part of the WordNet. WordNet ontology is used to generate semantically meaningful queries by deriving the synonyms related to the query terms.

Problem Definition

In a multi-database (integrated) system of a particular domain, the same entity may be stored with different names in different databases. Retrieving information from an integrated system, matches the user's query with available databases, through syntax; this is due to the fact that the traditional method of processing query depends on syntax. Since, the conventional query processing is sensitive to vocabulary, it is possible that the user's initial keywords do not get results of interest, but the relevant documents uses different term from the original query that are semantically equivalent to the user's term that capture user's intention.

For example, a synonym of a term found in the system, may be used in the query (TV and television, price and rate). Retrieving record from an integrated system often fail, because of syntactic and semantic differences. Consider Table 1:

Table 1: A sample relational database table

Id	Product name	price
1	Cellular phone	5000
2	Television	20000
3	Sound system	5000
4	Personal computer	3000

A user query for a "TV", from Table 1 return null, because, the tradition method of query processing is vocabulary sensitive, though, "TV" is implied by other term ("Television") which should be considered in processing the query.

Retrieving records that are semantically related to a target request will yield better results in multi-database system that may have different records describing the same entity (Amshakala & Nedunchezhian, 2011). This requirement is far beyond the capabilities of the conventional syntax based query processing. If semantic relation like synonyms could be included in the search, then semantically related terms may be retrieved. By replacing the query terms with a mechanism which can identify semantically similar terms, challenge posed by the use of different terms to define the same concept may be handled. These form the basis of the paper methodology.

Methodology

The paper adopts an approach that combines WordNet ontology as a semantic dictionary and query reformulation algorithm. The major idea is that data integration can be achieved if naming conflicts can be eliminate or resolved. Adopt semantic lexicon (WordNet) capable of determining synonyms and performing query reformulation help to resolve synonyms problems. A classical substitution principle is the underline approach. Given a search term, the paper developed a mechanism to find related terms and search for those related terms from WordNet. This is a complex task; since the system is syntax based. Therefore, the paper define some concepts that will be useful for in this approach.

Define $S = \{s_1, s_2, s_3, \text{----------}s_n\}$, to be the set of synonyms retrieved from the WordNet, where $s_n \in S$. It is a mapping from word phrases (S) to synset (s_n), that is $S \rightarrow s_n$. In particular, the mapping $S \rightarrow s_n$, connotes the following: S denotes a meaning of the (word) phrase s_k. For example: Television → {"TV", "Telly", "television", "telecast"}. This denotes that the word "television" and the synset "TV", "Telly", "television", "telecast", are semantically equivalent.

From the problem definition, it was asserts that, user may likely not enter exact term that matches the answer syntactically, however, the user(s) should be able to use or enter term or phrase that are semantically similar to the right answer. Thus, there is conceptual definition of how terms can be semantically related to one another. The set of synonyms are retrieved from WordNet (Jayaprabha & Somasundaram, 2011) database. The retrieved synonyms are ranked base on semantic similarity measurement. This was implemented using WordNet::Similarity (Patwardhan & Pedersen, 2006) that contains an algorithm for measuring semantic similarity.

Internally, WordNet uses Java WordNet search application interface (JAWS), a Java API to WordNet, to access the database. The system utilizes JAWS to retrieve and cluster the

synonyms. A query reformulation algorithm was developed that utilizes the retrieved synonyms to reformulate the user query based on the available synonyms and then generates hits from the database(s).

The architecture of the proposed system is shown in Figure 1. The user submit query and receive the output via the user interface and output panel respectively. The WordNet is far from being complete, therefore, the paper makes effort to extend the database to accommodate new terms; user can insert new terms vie user interface for inserting new term and the update WordNet module is responsible to update the WordNet database. The data source houses all the different databases in the data source. The databases in this approach are not physically present, but the system uses their addresses registered with the application to access and querying them remotely.

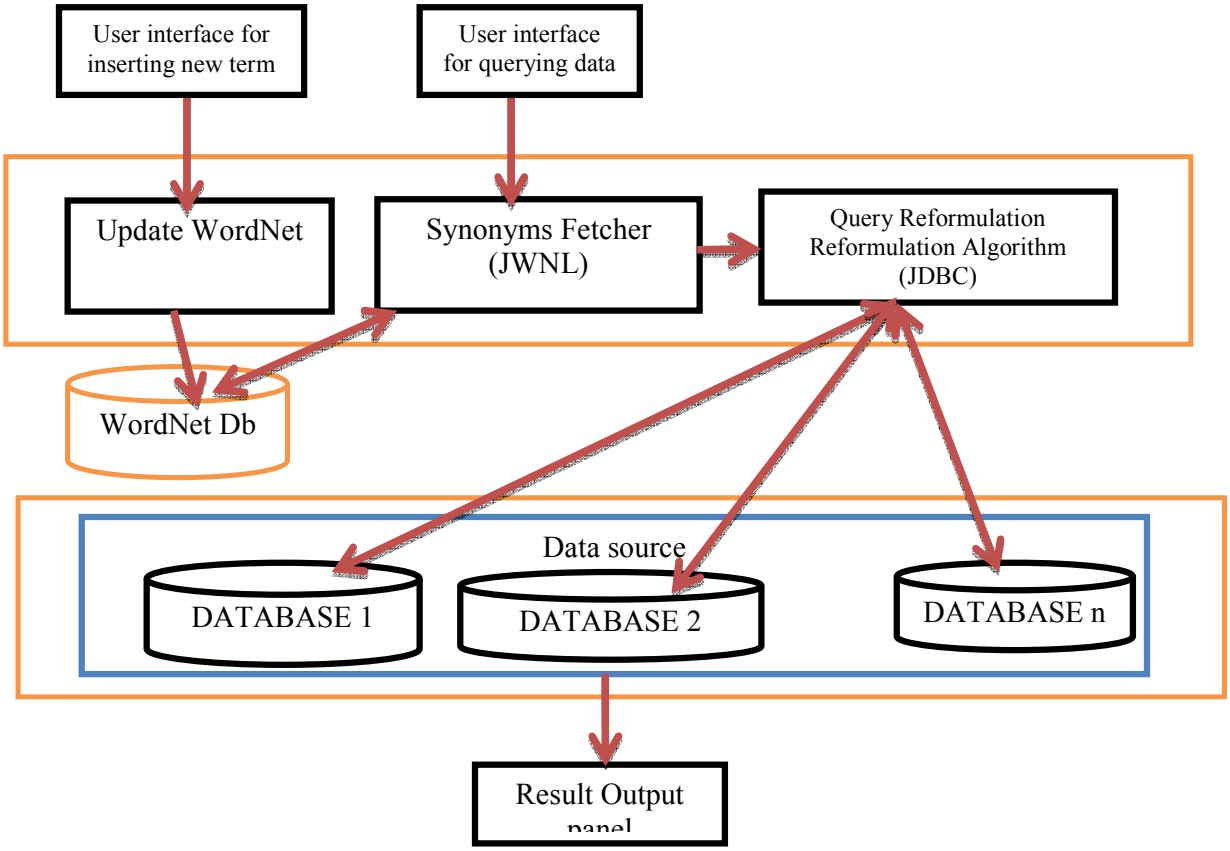

Figure 1: The System Architecture

Query reformulation

Query reformulation is also known as query expansion. Query expansion is the process of adding relevant terms to the original query (Asfari & Sansonnet, 2009). Query reformulation is a way of reformulating the user submits query based on the available synonyms from the WordNet. It is used to answer user's queries in more efficient manner by reformulating user submitted queries into semantically related concepts or synonyms. The reformulated query is called the semantic query (Ali & Khan, 2005). These semantic query is formed by using WordNet ontology support, which provide synonymous terms equivalent to keyword query term.

We propose a query reformulation algorithm, which our system will use in reformulating the input query based on the available retrieved synonyms. The algorithm is embedded in the

query reformulation module of our system. This is done in accordance to the following algorithm:

Define S = {s_1, s_2, s_3,----------s_n}, to be the set of synonyms retrieved from WordNet.
Define T = {t_1, t_2, t_3,----------t_n} to be the set of tables available in the system.
Define F = {f_1,f_2, f_3,----------f_n} to be set of field in table t_i
Result = dataset of possible output.
For each t_i ε T // table t_i in T, i = 1 to n.
For each f_j ε F // field f_j in T, j = 1 to n.
For each s_k ε S // s_k is a subset of S, where S is a set of synonyms, and k= 1 to n
Result = Result u SELECT * from T, where f_j contains s_k
End for
End for
End for
Return result.

Experimental Evaluation

The evaluation of the concept was carried out by implementing different databases using tables presented in Amshakala and Nedunchezhian (2011). The table is a categorization of terms and their synonyms, its domain is broad enough to be realistic, and the content of the table is applicable in the domain of e-commerce and is understandable by non-experts. Table 2, table 3 and table 4, are different tables in the application data sources.

Table 2: Item table from mysql database

```
mysql> use mysqldb;
Database changed
mysql> select * from item;
+------+------------------+-------+
| id   | product_name     | price |
+------+------------------+-------+
| 1    | cellular phone   | 5000  |
| 2    | television       | 20000 |
| 3    | sound system     | 5000  |
| 4    | personal computer | 30000 |
+------+------------------+-------+
4 rows in set (0.06 sec)
```

Table 3: Commodity table from derby database

ID	PRODUCT_NAME	PRICE
1	mobile	3000
2	telecast	25000
3	music	4000
4	computer	25000

Table 4: Product table from sqlite database

id	product_name	price
1	mobile phone	4000
2	tv	25000
3	stereo	5000
4	pc	20000
5	washer	10000

Results and Discussion

The framework is evaluated by implementing a database where terms and its possible synonyms are stored in different tables. The main interface to the system is shown in figure 7.

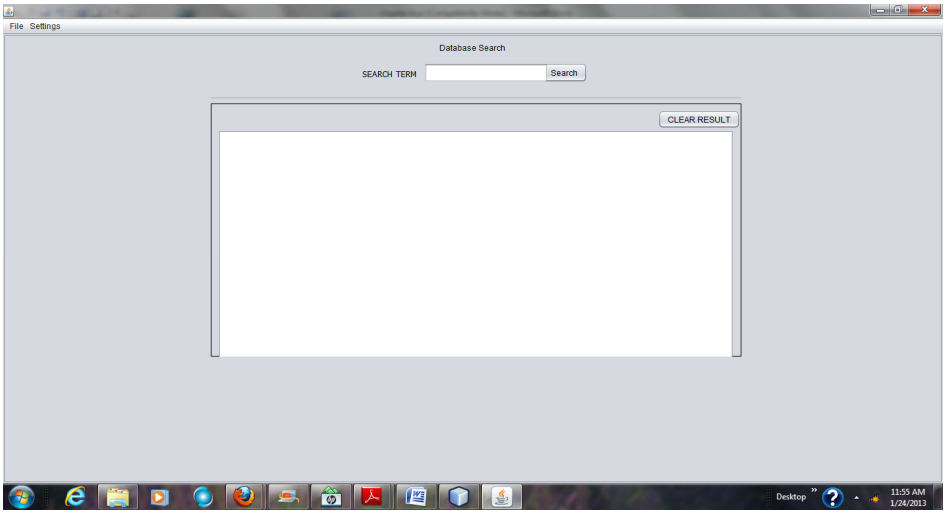

Figure 7: The main GUI

Figure 7, shows the main GUI developed using Java swing. It has two menu; file menu and settings menu. The file menu has one submenu-the exit menu. In addition, the GUI has a textbox that allows the user to search for term and a result panel to view the result.

The first evaluation was done without the semantic dictionary (WordNet), and it was observed that if user specifies a term which is not present in the database, it gives no hit. Although, the intended concepts or entity may be available. Figure 8 is the screen shot of no hit.

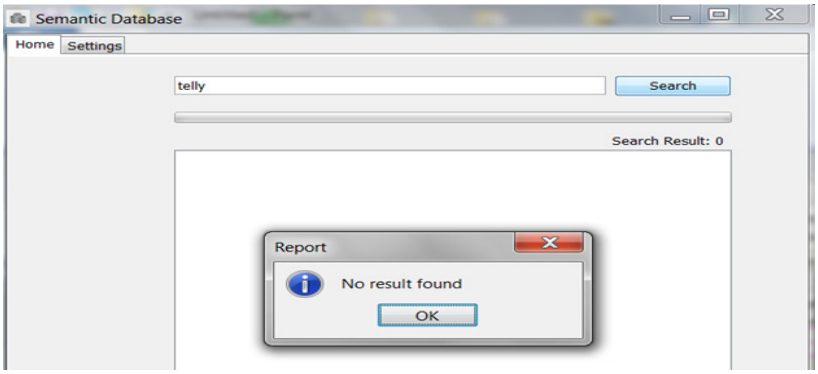

Figure 8: Screen shot of failed hit

The subsequent evaluation was done with the semantic dictionary fully incorporated and integrated into the database. A query was executed on the database and obtains the concepts or entities that match with the user's request. The system not only discovers the concept or entities that syntactically match with that of the request, it also retrieves concepts or entities that are synonymous when the exact match is not found.

For instance, if a user requests a music system, washing machine and television, the system retrieves stereo, washer and telly respectively, as shown in Figure 9, 10 and 11, respectively.

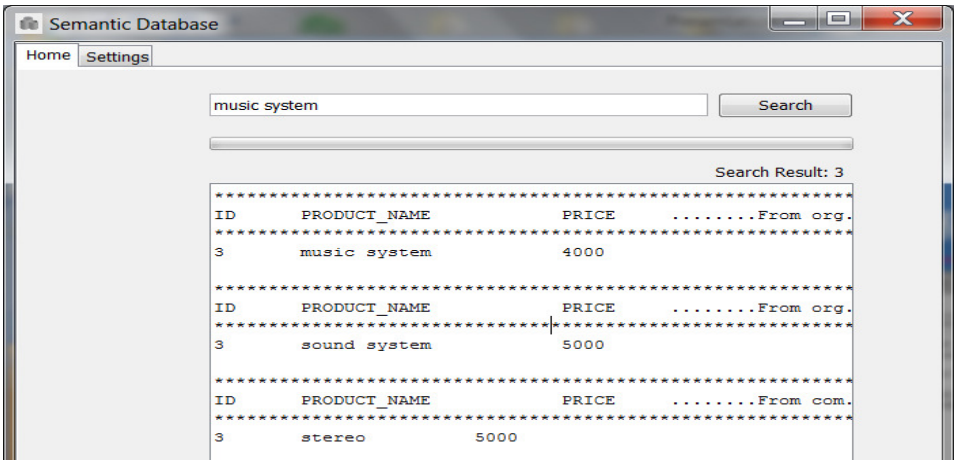

Figure 9: The system interface showing displaying result in the result panel

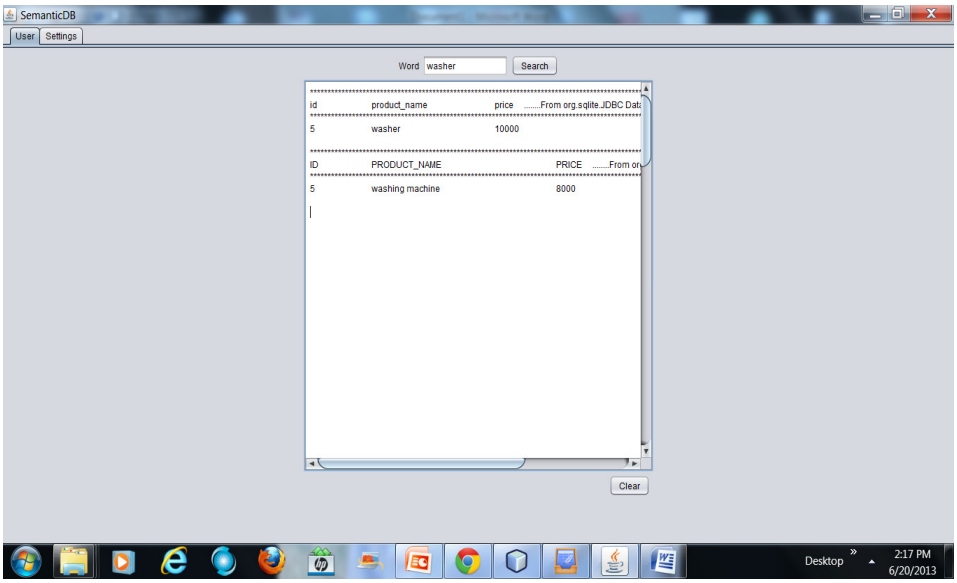

Figure 10: The system interface showing displaying result in the result panel

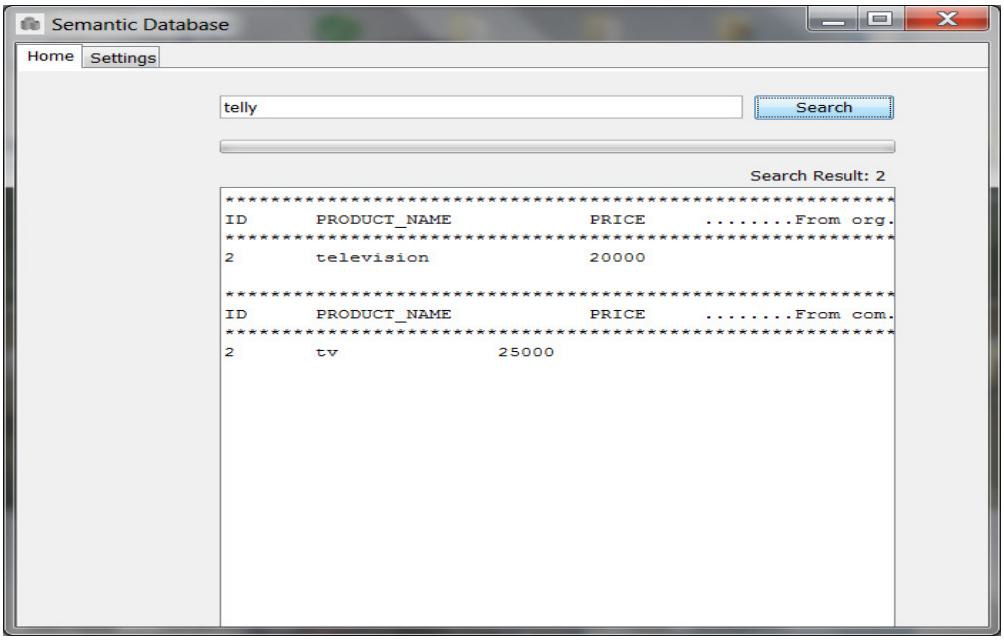

Figure 11: The system interface displaying result in the result panel

As observed from the figures above, though some instance where the term requested by the user is not available in the database, the system retrieves more semantically matching results. The system use the semantic dictionary (WordNet) to infers that music system, washer and television are all synonymous to stereo, washing machine and television respectively. The above results show an enhancement in the ability of retrieving concept based not only on exact meaning, but also on the existence of semantic relationships between the label terms.

The evaluation of the proposed approach with respect to syntax based search was performed in term of recall. For the comparison of the results, the evaluation was carried out on a system with 2.40GHz processor, 2GB RAM and on windows 7 operating system. Queries are executed on the system with and without the semantic dictionary using tables (1 - 4).

The use of semantic dictionary as proposed in this paper increase the recall of the user submitted queries compared to the syntax based query without semantic knowledge. The inclusion of semantically related terms has led to increase in the results and therefore more results are presented to the users. As the graph shown in Figure 1, the proposed approach considerably increase the user's recall.

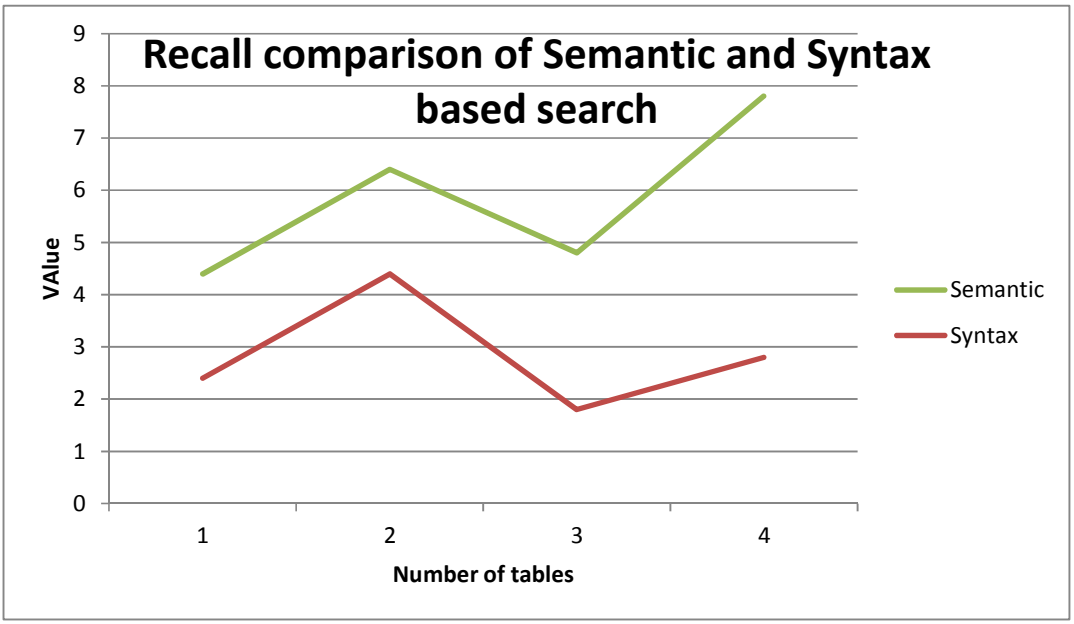

Figure 12: Recall comparison graph

Findings of the Research

The developed system was able to use Semantic knowledge to retrieve some result that captures the user intention, despite the fact that it is not categorically stated in the query. The result displayed in figure 9, 10 and 11, was possible because of the knowledge that music system, washing machine and television, are all synonymous to stereo, washer and telly respectively. The above results show an enhancement in the ability of retrieving concept based not only on exact meaning, but also on the existence of semantic relationships between the label terms.

Conclusion and Future Work

The technological advancement, among other things, has made available different databases in the domain of e-commerce. This paper present an approach for ontology-based data integration system, aimed at facilitating seamless transparent access to different databases. The relational databases were considered in their original form and format and make use of WordNet to extract potential relation between the terms. The designed application that integrate data sources and WordNet adopting the three layer architecture format. The WordNet module solves the problem of different name representations of same entity in the system, by providing terms that are synonymous to the user given query. The experimental evaluation turned out to be fairly effective in practical applications, with a particular set of data using knowledge of relations between words. The prototype designed in this paper has only been tested with simple terms, and has the capability to answer single term query. This is possibly the weakness of the developed system, as certain terms may only be relevant when seen in connection with one or more other terms. An enhancement on the system to accommodate more than a single term query will further improve the performance of the system.

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METHODOLOGICAL ISSUES IN THE APPLICABILITY OF HEDONIC MODELS IN HOUSE PRICE MEASUREMENT: A REVIEW

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Abstract
Accurate measurement of changes in housing prices is key to understanding the efficiency of the housing market. This paper therefore examines methodological issues in applying hedonic regression approach in housing market analyses and its usefulness in understanding housing prices. Findings from literature reveal that despite its drawbacks (model misspecification, inappropriate choice of functional form, multi-collinearity and omitted variable problem) hedonic models provide reliable measure of house prices and are likely to increase the decision making ability of policy makers and professional practice of surveyors when large datasets of similar properties and their attributes are available. This paper therefore concludes that hedonic models should be used in conjunction with other valuation methods as they provide valuers with additional information in the valuation process.

Keywords: *Housing; Housing Market; Hedonic; Implicit Price; Regression.*

Introduction

Since the classical work of Rosen on *'hedonic prices and implicit markets'* was published in 1974, there has been a preponderance within real estate literature of the application of hedonic models in determining the implicit prices of dwellings in urban housing markets. Several empirical contributions from the literature such as (Meen, 1996; Jones, Leishman, & Watkins, 2003; Huang, Wu, & Barry, 2010) have provided useful insights not only into the structure of urban housing markets (which was the highpoint of Grigsby (1963) exceptional seminal contributions to housing economic research) but also some underlying theories of urban housing market dynamics as well as explanations on the aggregation of housing demand.

Housing as a consumption good fulfils human physical need and his continued sustenance. However, housing price movements would have far-reaching implications on consumers' spending and saving patterns. These changes in housing price across different housing market segments create self-reinforcing effects on demand and supply and then back to housing price itself (Stein, 1995; Ortalo- Magne & Rady, 2004; Sing *et. al.,* 2006). The accurate measurement of changes in housing prices is equally key to understanding the investment behaviour of market participants and the efficiency of the housing market itself, especially, in periods of weak economic climate. As such, real estate market actors are bound to generate considerable interest in housing price trends and dynamics and link them back to some explicative factors.

Reliable housing price measurement is however a difficult task and has often been exacerbated by the peculiar nature of the housing market. The housing market is a dynamic entity, as its heterogeneous nature, the substitution effect of its attributes, plus the consumption-investment behaviour exhibited by its end users (Kim & Park, 2005) make long run equilibrium almost elusive. Since an accurate housing price is essential for various reasons, a pragmatic approach of determining house prices is hedonic pricing. This involves the use of datasets, by regressing both physical and location attributes of an area's housing stock using regression coefficients, (the characteristic prices) and the price can be estimated by summing up its characteristics prices. Hedonic models have shown to be cost effective and have produced efficient results using large datasets (Dodgson & Tophan, 1990; Crone & Voith, 1992). Hedonic models are equally likely to increase the decision making ability of policy makers, improve the professional practice of surveyors and cushion the effect of housing market recession (Nicol, 1996). However, this method has its drawbacks in terms of methodology, which stem from its choice of functional form and selection of independent variables, the inherent problems of heteroskedasticity, multicollinearity and choice of correct functional form (Gaetano, 2013; Fletcher et al., 2000; Martins-Filho & Bin, 2005). Undoubtedly an understanding and circumventing of these methodological issues would provide researchers in housing economics with a better knowledge of building parsimonious and robust hedonic models, which would in the end provide a far more useful insight into the structure and operation of the malleable urban housing markets.

In view of the foregoing, the objective of this paper is to provide a review of methodological issues surrounding the application of hedonic models for accurate house price measurement. This paper review issues by undertaking a discussion on the theoretical basis for hedonic pricing models. This is aptly followed by a review of empirical results on residential hedonic models to show most used housing attributes and those which consistently predict housing prices. The next section provides an overview of previous literature on methodological issues (hedonic models specification, appropriate choice of the functional form of the models and Specification of the correct dependent and independent variables) in housing price measurement. The final section presents the conclusions drawn on the basis of the review.

Theoretical Basis of Hedonic Pricing Models

Most urban real estate analysts have employed hedonic models as an appraisal tool consequent upon the work of Rosen (1974) which centre on the analysis of a market of a single good having many traits. Rosen (1974, p.34) define hedonic prices as "the implicit prices of attributes and are revealed to economic agents from observed prices of differentiated products and the specific amount of characteristics associated with them".

Given the assumption of a perfect competitive market that both buyers and sellers are well informed, housing prices would reflect both parties' preferences. As housing is heterogeneous, the selection of a dwelling means that a buyer select many different housing characteristics, and under market condition the equilibrium price locus will determine the marginal price for changes in each characteristics that make a house a heterogeneous product.

In the market, if Z^i is an amenity (in this case a house) having a range of housing characteristics (S_1, N_1, L_1), then households willingness to buy will be determined by their utility functions, as utility is derived from the individual characteristics. Such that on the demand side, the envelope of buyers' bid price for the house is given by B^i (s) and this will be influenced by income and preferences. The bid function depict the price buyers are willing to pay for a given dwelling unit by deriving a specific amount of utility there from (Ham, 2011). As such:

$B^i = f(Z^i, I, \alpha)$ .....(i)
Where (I) is the income and (α) is the household tastes and preferences. Z^i is the house with its array of housing attributes. Re-writing this, we have,

$B^i = f(S_1, N_1, L_1, I, \alpha)$ ..... (ii)
S_1 is the physical and structural characteristics of the house; N_1 is its neighborhood characteristics such as landscape and amenities while L_1 is the specific location within the market.

Thus, buyers' derive maximum utility when their bid function (B^i) = house price. It must be noted that the concavity of the buyers' utility function as seen in figure1 means that, their bid function increases at a decreasing rate as their corresponding characteristic increase. For example, if more additional units of apartment are acquired by a household, utility and hence value derived from acquiring an additional unit would decrease as more units of apartment are consumed. This is based on the law of diminishing marginal utility.

On the supply side, the sellers' offer function (O^1s) determines the minimum price sellers can give out their housing units in other to make profit, at a given level of output (Q) and a variable (μ) denoting the difference in firms' production costs:

$O^i = f(S_1, N_1, L_1, Q, \mu)$ ..... (iii)
The convexity of the production function in figure1 means a constant or increasing return to scale. Sellers' maximum production occur when their offer function (O^i) = price.

Fig.1 gives a graphical depiction this relation. The hedonic price ($P(z^i|z^{*k\neq i})$ locus for a house Z^i is determined where the envelope of buyers' bid (B^i) is in tangency to the envelope of sellers' offers (represented by the O^i). This also means that the implicit bid and offer price for any particular attribute will be at equilibrium when:
$B^i = O^i$; $B^i_{Si} = O^i_{Si}$; $B^i_{Li} = O^i_{Li}$; $B^i_{Ni} = O^i_{Ni}$. Here, B^i_{Si} and O^i_{Si} ; B^i_{Li} and O^i_{Li} as well as B^i_{Ni} and O^i_{Ni} are partial derivatives of B^i and O^i with respect to Si, Li and Ni.

Detailed theoretical underpinnings on hedonic models are discussed in Follain and Jimenez (1985) and Buchel and Hoesli (1995).

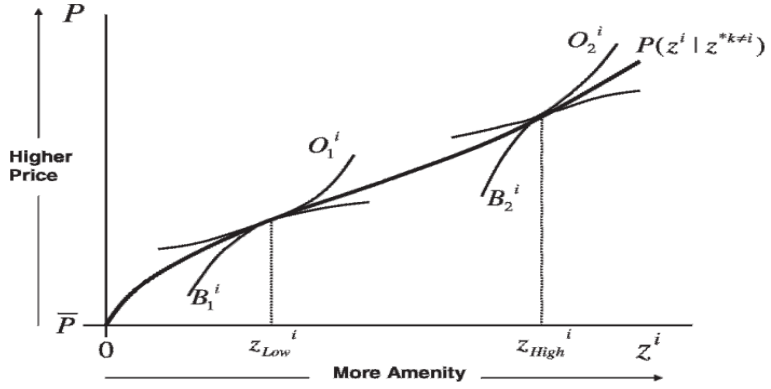

Fig1: Standard Hedonic Diagram of Amenity, *j*
Source: Jaren (2008)

Therefore, hedonic models probe the question of estimating the implicit price of housing characteristics, given the constraint that these housing characteristics are sold as a single

unit which cannot be unbundled in the market (Di pasquare and Wheaton, 1996 and Brunauer *et al,* 2009).

Variables Employed in Hedonic Regression and How They Best Predict Housing Price

Although economic theory provides no guide as to the variables that goes into model specification (Mason and Quigley, 1996), but existing literature by Basu and Thibodeau, (1998), Fan and Koh (2006) and Paez, *et al.* (2008) identify three broad factors: structural traits of the dwelling, location and neighbourhood factors. Typical examples of structural characteristics include floor area, lot size and bathrooms. With respect to location and neighbourhood factors, Galster (2003) mention that, "it does not mean that they are intrinsically coupled with the geography - some are physical environment (presence of scenery and neighbourhood image) others are related with individuals who lend their collective attributes to the space through aggregation (for example income and race)"

Table1: Most Frequent Housing Characteristics Used in Hedonic Pricing Models

Variables	Appearances	No. of times Positive	No. of times Negative	No Significant Difference
Lot size	52	45	0	7
Square feet	69	62	4	3
Brick	13	9	0	4
Age	78	7	63	8
No. of Stories	13	4	7	2
No. of Bathrooms	40	34	1	5
No. Of Rooms	14	10	1	3
Fireplace	57	43	3	11
Full Baths	37	31	1	5
Air-conditioning	37	34	1	2
Basement	21	15	1	5
Garage spaces	61	48	0	13
Pool	31	27	0	4
Distance	15	5	5	5
Time on Trend	13	2	3	8
Time on Market	18	1	8	9

Source: Adapted from Sirmans *et al, (*2005) in the composition of hedonic pricing models, p.10.

In this regards, Sirmans *et al.* (2005) examine about 125 empirical studies on hedonic models. Some of their results which are presented in table 1 and 2 show most used housing attributes and those which consistently predict housing prices based on number of times their estimated coefficients have been positive, negative or show no significant difference with housing price. Table 1 indicates that twenty (20) housing characteristics are the most frequently used. The frequency of each of the characteristics is give by its appearance, which means for example that out of 125 empirical researches, 78 of them considered AGE in which 63 of these concluded that age is negatively correlated with housing price, 7 reveals a positive relationship and 6 shows that there is no significant relationship between age and housing price. Attributes that feature dominantly are age and square feet. These are followed by garage, fire place and lot size. Others characteristics that are used include bathroom, air conditioning among others as shown in the table. It must be mentioned that

some of the housing characteristics like lot size and Ln lot size (log of lot size) are the same though with different parameter specification so as to allow for the non-linearity relationship between lot size and housing price.

Table2: Housing Characteristics that Best Predict House Price

Housing Characteristics	Appearances	No. of times Positive	No. of times Negative	No Significant Difference	Interpretation of Coefficients of Determination
Lot size	52	45	0	7	1.50%***
Square feet	69	62	4	3	0.04-0.07%**
No. of Bathrooms	40	34	1	5	10-12%**
Age	78	7	63	8	-1.00%**
Fireplace	57	43	3	11	6-12%**
Air-conditioning	37	34	1	2	4-13%**
Basement	21	15	1	5	12-16%**
Garage spaces	61	48	0	13	6-12%**
Pool	31	27	0	4	4-13%**

**contribution to price across geographical locations based on coefficient estimates. ***Estimates from Sirmans and Macpherson (2003).
Source: Modified from Sirmans et al. (2005) in the composition of hedonic pricing models.

Again, in table 2 the characteristics which best predict housing prices are selected from table 1 based on those having higher frequency relative to the 125 empirical studies and the extent to which those selected are positively or negatively correlated with housing price. Added to these, are their coefficient of determination across different hedonic studies so as to estimate those that indicate consistency across various hedonic locations. The table depicts that nine housing characteristics such as square feet, lot size, age, fireplace, number of bathrooms and pool best predict prices. These attributes were used at least 21 and at most 78 of the 125 empirical studies with all having positive coefficients of determination except age. This implies all are consistent in predicting house prices across different locations though age has negative contribution. Given the knowledge of these variables in housing market analyses, valuers and surveyors can work with them as additional information to aid the valuation process and improve their accuracy of value-price determination in the property market.

Again, Vanderford *et al*. (2005) examine 13 studies that employed local and nationwide data to predict housing price. They show that though, neighbourhood attributes were fairly inconsistent across studies, physical characteristics of dwellings such as lot size, square feet, size of garage and number of fire place produce significant results across the studies, buttressing the consistency in Sirmans *et al*. (2005) results. However, the results should be interpreted with caution. For example, garage in all cases never have any negative significant effect but have shown no significant difference on housing prices in 13 similar studies. The reason might not be unconnected with difference in geographical boundaries but also parameter uncertainty (Zietz *et al.,* 2008).

Methodological Issues in Application of Hedonic Pricing Models

Specification of Hedonic Price Functions

Though, not in all cases, hedonic models are usually used in a two-step procedure. The first stage involves determining the price for the housing characteristics and the second, to recover the structural parameters of demand and supply by treating the partial derivatives of

those characteristics as observations of their inverse demand and supply functions (Horowitz, 1987 and Malpezzi, 2003). For example, the price of individual housing characteristics calculated in the first stage can be placed on the left side of the equation so as to estimate the demand for each characteristic by including household data like income, which affects demand and supply.

The specification of parsimonious hedonic functions is however a difficult task, especially at the first stage since the second stage is presumed to be linear. There exists for instance, a non-linear relationship in the first stage, between price and housing characteristics: because the heterogeneity of property means its characteristic prices are not constant but vary with quantity (Malpezzi, 2003; Kestens, Thériault & Rosiers, 2006; Bruaner *et al.,* 2009).

Like other regression models, proper specification of the correct independent variables and functional form is required to prevent inconsistent house price estimates (Mason & Quigley 1996; Wang & Zorn 1997; Meese & Wallace 1997 & Bourassa *et al.* 2005). Inconsistency in house price estimates have been mentioned by Gatzlaff and Haurin (1997), Pace and Gilley (1998) and Bourassa *et al.* (2007) to be discernible when any of the assumptions of regression model is violated (for example the assumption that the disturbance error should be independent among the variables). Fletcher et al. (2000), point out that not using a semi log functional form may violate the assumptions and therefore result in heteroscedasticity. Heteroscedasticity occurs when the variances of the disturbance term of the model are unequal as a result of missing variables (for example when the variance of the disturbance term differs by property type).

Hedonic models often require large datasets (location and neighbourhood attributes). These datasets are onerous to assemble and even when available, the specification of these many spatial-based attributes could lead to complex models (Hoesli *et al.,* 1997 & Dubin *et al,.* 1999; Mueller & Loomis. 2008). A detailed specification of the correct dependent and explanatory variables as well as the relevant choice of functional form for the model must suffice.

The Dependent Variable and Selection of the Explanatory Variables

Economic theory on its own does not give a clear-cut guide of the variables that enter into a hedonic model. Because real estate has some peculiar characteristics which vary across locations and property type, the selection of the right dependent and explanatory variables is partly an empirical one in addition to what economic theory provides (Pace, 1995 & Hannonen, 2005).

With respect to the dependent variable, the choice of is always between rent, housing price and appraisal value. Problems however arise from different units of measurement (for example, should the net or gross sale price be specified as the predictor?). According to Hoesli and Macgregor (2000) and Sirmans *et al.* (2005), a preferred option of dependent variable is the recent selling price. Using the observed selling price is thought to minimise bias as compared to self assessed or appraisal value. This is because, large transaction volume of traded housing units provide higher rate of price information flow and reduces price dispersion that causes heteroscedasticity (Yiu *et al.* 2006). Unlike appraisal values which are based on valuers' judgement, housing transaction data give accurate reflection of price change in the market. However, appraisal values are typically employed as a dependent variable in a thin market when transactions are infrequent.

Conversely, choosing the correct set of explanatory variables is by no means an easy task (Mason & Quigley, 1996). Butler (1982) and Gat (1996) mention that the list of these

variables is not exhaustive, but that most variation in housing prices can best be captured using few variates. While (Butler, 1982; Gat, 1996) opine that inclusion of numerous variables would result in multi-collinearity (for example neighbourhood socioeconomic variables are correlated with unobserved neighbourhood quality among the explanatory variables), Pindyck and Rubinfeld (1998) rightly caution that the omission of variables in the model may produce biased and inconsistent regression estimate. However, Malpezzi (2003) further argues that "the same correlation between omitted and included variables that biases individual coefficient estimates can help improved prediction from a 'sparse' model". Therefore, while the availability of variables which influence housing price is important, the removal of variables from the model should be done with caution.

The Choice of an Appropriate Functional Form

Since the non- linear relationship between housing price and housing attributes would affect the model results, parameter specification in terms of the appropriate functional form would mitigate this problem. Economic theory does not suggest however the correct model functional forms (Pace, 1993; Pace, 1995; Anglin & Gencay, 1996). This makes Freeman (1993) assert that "any functional form is plausible in hedonic price function because the form could reflect the hedonic price structure of different housing markets". That is, the functional form could be concave, convex or linear.

In view of the nature of these functional forms (for instance, linear, semi-log and log-log) across different housing markets, Halvorsen and Pollakowski (1981) reveals that, by including these functional forms in the general quadratic Box-`Cox model of 1964, a flexible or appropriate functional form can be determined through statistical tests such as likelihood ratio tests. Most empirical analyses have applied semi logarithmic form over the linear, double log and translog specification (Forrest, 1991; Wooldridge 2003). Compared to the translog form which has the problem of multi-collinearity due to large information requirements of the model (Hannonen, 2005), Wooldridge (2003) reveals that, semilog functional form can reduce heteroscedasticity, as the variance of the error term for the house price is expected to be constant (Goodman & Thibodeau, 1995; Fletcher *et al.,* 2000; Melpezzi, 2003). Also, while the multiplicative form of the log-log is intrinsically linear (Hannonen, 2005), such transformation which gives a model which is linear in parameters, makes inference difficult. Melpezzi (2003) and Schultz and Schmitz (2009) explain that a semi-log model gives a simple interpretation of the extent to which the independent variables predict price, expressed as percentage change in the dependent variable.

The role of functional form in hedonic models is that, if the first stage of the model were to be linear (the first stage is always non-linear as the price of one housing characteristics is affected by the quantity of another), then the marginal prices of the housing attributes would be constant and needless to estimate the second stage demand and supply function (Malpezzi, 2003).

Conclusion

This paper has provided a review of literature on resolving methodological issues and understanding housing prices using hedonic models. This is against the background that, it is unlikely that our understanding of the economic context within which housing is placed will improve without refinement in the measurement of housing price changes. In addition, this paper provided a formal theoretical exposition of hedonic pricing models and proceeded with discussions on variables employed in most hedonic empirical studies and how they best predict house prices. Hedonic model is a pricing model which has been found to be cost effective and devoid of inconsistencies in house price estimate, given a robust dataset. However, by overcoming some of its inherent shortcomings, such as misspecification of the

hedonic models and the functional form, multi-collinearity and omitted variable problem, hedonic models are likely improve the professional practice of valuers by providing additional information to the valuation process.

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ARTICLES AND RESEARCH REPORTS ON MATHEMATICS

MULTIVARIATE EXTENSION TO SUDOKU SQUARE DESIGN'S MODELS

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Abstract
Sudoku square design consists of treatments that are arranged in a square array such that each row, column or sub-square of the design contains each of the treatments only once. Several univariate analysis of variance models were presented in the literature for the design, but little or no attention is paid on the multivariate or generalized linear model for the design. This paper proposed multivariate extension of the analysis of variance (MANOVA) for the design and its generalized linear model. The significant tests were carried out at 0.05 alpha level of significance and the results show that effects are significant for Hui-Dong and Ru-Gen model and model II.

Introduction

A Sudoku square design is an experimental design with k^2 experimental units that are divided into k rows, k columns, and k boxes (i.e, each box contains k experimental units with 1 through k treatments). In this design each treatment has k replications (Hui-Dong and Ru-Gen, 2008). Detail description on how to design and randomize a Sudoku Square are presented in Hui-Dong and Ru-Gen (2008). However, the Sudoku design presented by Hui-Dong and Ru-Gen (2008) does not contain row-blocks or column-blocks effects. Subramani and Ponnuswamy (2009) extended the design to include row-blocks and column-blocks effects in which they called Sudoku designs-Type I. Methods of constructing the Sudoku design and analysis are discussed by Hui-Dong and Ru-Gen (2008), Subramani and Ponnuswamy (2009), and Danbaba (2016).

The construction of orthogonal Sudoku design has been considered by statisticians and mathematicians. Bailey *et al*. (2008) presented several results for construction of orthogonal Sudoku designs. Subramani (2012) extended the Sudoku designs to Orthogonal (Graeco) Sudoku square designs. A simple method of constructing Graeco Sudoku square designs of odd order is presented by Subramani (2012). Danbaba (2016a) presented a simple row (or column) permutation of matrix for construction of Graeco Sudoku square designs that does not require coding of treatments. Recently, it has been shown that Sudoku design may be partial or incomplete, see Béjar *et al*. (2012) and Mahdian and Mahmoodian (2015).

A partial Sudoku design is a partially filled block matrix, with some empty cells, which also satisfies that each Latin letter appears only once in row (column or sub-block), see Mahdian and Mahmoodian (2015). This partial Sudoku design has been shown to be NP-complete for the particular case of square sub-blocks (k rows and k columns in each sub-block), see Kanaana and Ravikumar (2010). It was reported in Béjar *et al*. (2012) that even when sub-blocks are not square the completion problem is also NP-complete. In general, it is an NP-complete problem to determine if a partial Sudoku square is completable (Colbourn 1984; Mahdian and Mahmoodian 2015).

Donovan *et al*. (2015) and Kumar *et al*. (2015) studied the Sudoku based space filling designs. Recently, Danbaba (2016b) proposed combined analysis of multi-environment experiments conducted via Sudoku square designs of odd order where the treatments are the same to the whole set of experiments. Danbaba (2016a) proposed a simple method of constructing Samurai Sudoku designs and orthogonal (Graeco) Samurai Sudoku design. He

also discussed linear models and methods of data analysis for these designs. The linear models and methods of data analysis for all the Sudoku designs considered so far are on univariate analysis of variance.

This paper proposed a multivariate procedure for the analysis of variance of Sudoku design. Sum of squares for analysis of variance of the design are presented and illustrated with some hypothetical data.

Method

Hui-Dong and Ru-Gen (2008) proposed the following linear model for Sudoku square design as

$$y_{(ij)lm} = \mu + \alpha_i + \beta_j + \gamma_l + \theta_m + \varepsilon_{(ij)lm} \begin{cases} i = 1,2,\ldots,k \\ j = 1,2,\ldots,k \\ l = 1,2,\ldots,k \\ m = 1,2,\ldots,k \end{cases} \quad (1)$$

where $y_{(ij)lm}$ is an observed value of the plot in the lth row and mth column, subjected to the ith treatment and jth box; μ is the grand mean, $\alpha_i, \beta_j, \gamma_l, \theta_m$ are the main effects of the ith treatment, jth box, lth row and mth column, respectively, ε_{ijm} is the random error.

The proposed multivariate extension of that model is

$$\mathbf{y}_{(ij)lm} = \boldsymbol{\mu} + \boldsymbol{\alpha}_i + \boldsymbol{\beta}_j + \boldsymbol{\gamma}_l + \boldsymbol{\theta}_m + \boldsymbol{\varepsilon}_{(ij)lm} \quad (2)$$

where $\mathbf{y}_{(ij)lm}$ is a p-vector-valued observations and $\boldsymbol{\varepsilon}_{(ij)m} \sim N_p(0, \Sigma)$

The MANOVA Table and hypotheses of interest are as follows:

Table 1: MANOVA table for Hui-Dong and Ru-Gen Model

Source	**df**	**SSP**
Treatments (α)	k-1	$D_\alpha = \sum_{i=1}^{k} \frac{y_{i\ldots} y'_{i\ldots}}{k} - \frac{y_{\ldots} y'_{\ldots}}{k^2}$
Boxes (β)	k-1	$D_\beta = \sum_{i=1}^{k} \frac{y_{j\ldots} y'_{j\ldots}}{k} - \frac{y_{\ldots} y'_{\ldots}}{k^2}$
Rows (γ)	k-1	$D_\gamma = \sum_{i=1}^{k} \frac{y_{l\ldots} y'_{l\ldots}}{k} - \frac{y_{\ldots} y'_{\ldots}}{k^2}$
Columns (θ)	k-1	$D_\theta = \sum_{i=1}^{k} \frac{y_{\ldots m} y'_{\ldots m}}{k} - \frac{y_{\ldots} y'_{\ldots}}{k^2}$
Error	(k-1)(k-1)	$D_e = \sum_{i=1}^{k} y_{ijlm} y'_{ijlm} - \frac{y_{i\ldots} y'_{i\ldots}}{k^2}$
Total	k^2 -1	$D_T = \sum_{i=1}^{k} y_{ij(kl)} y'_{ij(kl)} - \frac{y_{\ldots} y'_{\ldots}}{k^2}$

H_α : all $\boldsymbol{\alpha}_i$ are equal

H_β : all $\boldsymbol{\beta}_i$ are equal

H_γ : all $\boldsymbol{\gamma}_i$ are equal

H_θ : all $\boldsymbol{\theta}_i$ are equal

Subramani and Ponnuswamy (2009) constructed and analyzed Sudoku designs of which four types of univariate models were suggested. In this paper the following multivariate alternative models are suggested for analysis of Sudoku designs of odd order:

Type 1

$$y_{ij(k,l,p,q)} = \mu + \alpha_i + \beta_j + \tau_k + C_p + \gamma_l + s_q + \varepsilon_{i,j(k,l,p,q)} \quad (3)$$

i, j = 1, 2, ...,*m and k, l, p, q* = 1, 2, ..., m^2

where μ= General mean

α_i = i^{th} Row block effect

β_j = j^{th} Column block effect

τ_k = k^{th} Treatment effect

r_l = l^{th} Row effect

c_p = p^{th} Column effect

s_q = q^{th} Square effect

$\varepsilon_{i,j(k,l,p,q)}$ = is the error component assumed to have vector mean zero and constant covariance Σ

Let $Y_{..j..}$ be the row-box (or row block) total and $Y_{i.j..}$ be the column-box (or column block) totals. The respective sum of squares and product matrices for row-block and column-block are

$$D_{\alpha\theta} = \sum_{i=1}^{k} \frac{y_{i...} y_{i...}'}{m^2} - \frac{y_{....} y_{....}'}{m^3}$$
$$D_{\beta\theta} = \sum_{i=1}^{k} \frac{y_{j...} y_{j...}'}{m^2} - \frac{y_{....} y_{....}'}{m^3} \quad (4)$$

The respective sum of squares and product matrices for rows within row-block and column within column-block are

$$D_{\alpha(\alpha\theta)} = \sum_{i=1}^{k} \frac{y_{i(j)...} y_{i...}'}{m^2} - \sum_{i} \frac{y_{....} y_{....}'}{m^3}$$
$$D_{\beta(\beta\theta)} = \sum_{i=1}^{k} \frac{y_{p(j)...} y_{j...}'}{m^2} \quad \sum_{i} \frac{y_{...j} y_{...j}'}{m^3} \quad (5)$$

The respective sum of squares and product matrices for boxes within row-block and boxes within column-block are

$$D_{\beta(\beta\theta)} = \sum_{i=1}^{k} \frac{y_{r(j)...} y_{r(j)...}'}{m^2} - \sum_{m} \frac{y_{...j} y_{...j}'}{m^3}$$
$$D_{\alpha(\alpha\theta)} = \sum_{j=1}^{k} \frac{y_{s(i)...} y_{s(i)...}'}{m^2} - \sum_{m} \frac{y_{...i} y_{...i}'}{m^3} \quad (6)$$

Table 2: MANOVA Table of Sudoku design of Type I

Source	df	SSP
Treatments	k – 1	D_γ
Row blocks	1	$D_{\alpha\theta}$
Column block	1	$D_{\beta\theta}$
Rows	k – 1	D_α
columns	k – 1	D_β
Boxes	k – 1	D_θ
Error	1	
Total	$k^2 - 1$	D_T

Type II

$$y_{ij(k,l,p,q)} = \mu + \alpha_i + \beta_j + \tau_k + \gamma(\alpha)_{l(i)} + C(\beta)_{p(j)} + s_q + e_{i,j(k,l,p,q)} \quad (7)$$

i, j, l, p = 1, 2, ...,*m and k, q* = 1, 2, ...,m^2

where μ= General mean
α_i = i^{th} block (Row) effect
β_j = j^{th} block (Column) effect
τ_k = k^{th} treatment effect
$r(\alpha)_{l(i)}$ = l^{th} row effect nested in i^{th} block (row)
$c(\beta)_{p(j)}$ = p^{th} column effect nested in j^{th} block (column)
s_q = q^{th} square effect
$\varepsilon_{i,j(k,l,p,q)}$= the error component assumed to have vector mean zero and constant covariance Σ

Table 3: MANOVA Table of Sudoku design of Type II

Source	df	SSP
Treatments	k – 1	D_γ
Row blocks	1	$D_{\alpha\theta}$
Column block	1	$D_{\beta\theta}$
Rows within row block	2	$D_{\alpha(\alpha\theta)}$
columns within column block	2	$D_{\beta(\beta\theta)}$
Boxes	k – 1	D_θ
Error	2	
Total	$k^2 - 1$	D_T

Type IV

$$y_{ij(k,l,p,q,r)} = \mu + \alpha_i + \beta_j + \tau_k + \gamma(\alpha)_{l(i)} + c(\beta)_{p(j)} + s(\alpha)_{q(i)} + \pi(\beta)_{r(j)} + \varepsilon_{ij(k,l,p,q,r)} \quad (8)$$

i, j, l, p, q, r = 1, 2,. . .,*m and k* = 1, 2,. . .,m^2
where
μ = General mean
α_i = i^{th} Row block effect
β_j = j^{th}Column block effect
τ_k = k^{th}Treatment effect
$r(\alpha)_{l(i)}$ = l^{th} Row effect nested in i^{th} row block effect
$c(\beta)_{p(j)}$ = p^{th} Column effect nested in j^{th} column block effect
$s(\alpha)_{q(i)} - qth$ Horizontal square effect nested in ith Row block effect
$\pi(\beta)_{r(j)} = rth$ vertical square effect nested in the jth column block effect
$\varepsilon_{ij(k,l,p,q,r)}$ = the error component assumed to have vector mean zero and constant covariance Σ

Table 4: MANOVA table of Sudoku design of Type IV

Source	df	SSP
Treatments	k – 1	D_γ
Row blocks	1	$D_{\alpha\theta}$
Column block	1	$D_{\beta\theta}$
Rows within row block	2	$D_{\alpha(\alpha\theta)}$
columns within column block	2	$D_{\beta(\beta\theta)}$
Boxes within row block	2	$D_{\theta(\alpha\theta)}$
Boxes within column block	2	$D_{\beta(\beta\theta)}$
Error	2	
Total	$k^2 - 1$	D_T

Muiltivariate Test Statistics used

All the null hypotheses ($H_\alpha, H_\beta, H_\gamma, H_\theta$) of main-effect are rejected at α level of significance if

(i) Roy Largest Root : $\frac{\lambda_a}{\lambda_a + 1} > \theta(\min(k-1, p), q, v),$

(ii) Lawley-Hoteling : $\sum_{i=1} \lambda_i > \theta(\min(k-1, p), q, v)$

(iii) Wilk's Lambda : $\Lambda = \frac{|D|}{|D+D|} < \Lambda(p, k-1, g)$

(iv) Pillai: $\sum_{i=1} \frac{\lambda_i}{\lambda_i + 1} > \theta(\min(k-1, p), q, v)$ (Timm,1975)

Where
g is the degree of freedom for error

$$q = \frac{1}{2}(|k - 1 - p| - 1) \quad v = \frac{1}{2}(g - p - 1)$$

Results

$y_{(ij)lm}$ is observation i[th] treatment in the j[th] box on the l[th] row in mth column. Fig.1 shows the arrangement of treatments used for the study, it is a Sudoku Square design of order four. While Fig.2 revealed the dependent variable $y_{(ij)lm}$ each of these variables represent more than one responses in each plot i.e (Multivariate case). However, each of the $y_{(ij)lm}$'s in Fig 2 is written in a linear model, which together forms the generalized linear model as seen in equation 10.

		1	2	1	2
1	1	A	B	C	D
	2	D	C	B	A
2	1	B	A	D	C
	2	C	D	A	B

Fig.1: Sudoku Square design of order 4 showing treatment arrangement

		1	2	1	2
1	1	y_{1111}	y_{1221}	y_{1332}	y_{1442}
	2	y_{2141}	y_{2231}	y_{2322}	y_{2412}
2	1	y_{3123}	y_{3213}	y_{3344}	y_{3434}
	2	y_{4133}	y_{4243}	y_{4314}	y_{4424}

Fig. 2: Sudoku square design of order 4 showing dependent variable

$$\begin{bmatrix} y_{1111} \\ y_{1221} \\ y_{1332} \\ y_{1442} \\ y_{2141} \\ y_{2231} \\ y_{2322} \\ y_{2412} \\ y_{3123} \\ y_{3213} \\ y_{3344} \\ y_{3434} \\ y_{4133} \\ y_{4243} \\ y_{4314} \\ y_{4424} \end{bmatrix} = \begin{bmatrix} 1&1&0&0&0&1&0&0&0&1&0&0&0&1&0&0&0 \\ 1&1&0&0&0&0&1&0&0&0&1&0&0&1&0&0&0 \\ 1&1&0&0&0&0&0&1&0&0&0&1&0&0&1&0&0 \\ 1&1&0&0&0&0&0&0&1&0&0&0&1&0&1&0&0 \\ 1&0&1&0&0&1&0&0&0&0&0&0&1&1&0&0&0 \\ 1&0&1&0&0&0&1&0&0&0&0&1&0&1&0&0&0 \\ 1&0&1&0&0&0&0&1&0&0&1&0&0&0&1&0&0 \\ 1&0&1&0&0&0&0&0&1&1&0&0&0&0&1&0&0 \\ 1&0&0&1&0&1&0&0&0&0&1&0&0&0&0&1&0 \\ 1&0&0&1&0&0&1&0&0&1&0&0&0&0&0&1&0 \\ 1&0&0&1&0&0&0&1&0&0&0&0&1&0&0&0&1 \\ 1&0&0&1&0&0&0&0&1&0&0&1&0&0&0&0&1 \\ 1&0&0&0&1&1&0&0&0&0&0&1&0&0&0&1&0 \\ 1&0&0&0&1&0&1&0&0&0&0&0&1&0&0&1&0 \\ 1&0&0&0&1&0&0&1&0&1&0&0&0&0&0&0&1 \\ 1&0&0&0&1&0&0&0&1&0&1&0&0&0&0&0&1 \end{bmatrix} \begin{bmatrix} \mu \\ \alpha_1 \\ \alpha_2 \\ \alpha_3 \\ \alpha_4 \\ \beta_1 \\ \beta_2 \\ \beta_3 \\ \beta_4 \\ \gamma_1 \\ \gamma_2 \\ \gamma_3 \\ \gamma_4 \\ \theta_1 \\ \theta_2 \\ \theta_3 \\ \theta_4 \end{bmatrix} + \begin{bmatrix} \varepsilon_{1111} \\ \varepsilon_{1221} \\ \varepsilon_{1332} \\ \varepsilon_{1442} \\ \varepsilon_{2141} \\ \varepsilon_{2231} \\ \varepsilon_{2322} \\ \varepsilon_{2412} \\ \varepsilon_{3123} \\ \varepsilon_{3213} \\ \varepsilon_{3344} \\ \varepsilon_{3434} \\ \varepsilon_{4133} \\ \varepsilon_{4243} \\ \varepsilon_{4314} \\ \varepsilon_{4424} \end{bmatrix}$$

$$\mathbf{Y}_{16\times 1} = \mathbf{X}_{16\times 17}\ \boldsymbol{\beta}_{17\times 1} + \boldsymbol{\varepsilon}_{16\times 1} \tag{9}$$

The multivariate extension of this model is proposed as follows:

$$\mathbf{Y}_{16\times n} = \mathbf{X}_{16\times 17}\ \boldsymbol{\beta}_{17\times n} + \boldsymbol{\varepsilon}_{16\times n} \tag{10}$$

Illustration

					$Y_{i..l}$	$Y_{i..}$
	A(2 1)	B(1 3)	C(3 1)	D(2 5)	(8 10)	(20 20)
	D(1 3)	C(2 5)	B(5 1)	A(4 1)	(12 10)	
	B(2 3)	A(2 4)	D(3 4)	C(2 3)	(9 14)	(22 25)
	C(3 4)	D(4 3)	A(5 2)	B(1 2)	(13 11)	
$Y_{.jk.}$	(8 11)	(9 15)	(16 8)	(9 11)	(42 45)	
$Y_{.j..}$	(17 26)		(25 19)			

Fig. 3: Hypothetical data for Sudoku square design of order 4.

Fig 3 is a hypothetical data used for the analysis, procedures for the estimation of various sums of squares and products (SSP) are obtained using the statistics in Table 1 as well as equations 4-6 and the summaries are presented in Tables 5 – 8.

The process of obtaining the multivariate significant tests for various effects for the models is that, since the tests described in section 2.1 are functions of eigenvalues λ_i, the values of these eigenvalues are obtained and the calculated values for the multivariate tests are as well obtained using statistics described in section 2.1 and the summaries of the significant tests for the models are also presented in Tables 9-24.

From the data above, we have

Treatment (trt) Total

A	B	C	D
(13 8)	(9 9)	(10 13)	(10 15)

Box Total

B1	B2	B3	B4
(6 12)	(14 8)	(11 14)	(11 11)

$cf = \frac{y_{...}y'_{...}}{k^2}$, $y_{...} = \begin{pmatrix}42\\45\end{pmatrix}$

$$cf = \frac{\begin{pmatrix}42\\45\end{pmatrix}\begin{pmatrix}42 & 45\end{pmatrix}}{4\times 4} = \begin{pmatrix}110.2500 & 118.1250\\118.1250 & 126.5625\end{pmatrix}$$

$$\sum y_{ijlm}^2 = \begin{pmatrix}2\\1\end{pmatrix}\begin{pmatrix}2 & 1\end{pmatrix}+\ldots+\begin{pmatrix}1\\2\end{pmatrix}\begin{pmatrix}1 & 2\end{pmatrix} = \begin{pmatrix}136 & 108\\108 & 155\end{pmatrix}$$

$$SSP_{Total} = \begin{pmatrix}136 & 108\\108 & 155\end{pmatrix} - cf = \begin{pmatrix}25.750 & -10.1250\\-10.1250 & 28.4375\end{pmatrix}$$

$$SStrt = \frac{\begin{pmatrix}13\\8\end{pmatrix}\begin{pmatrix}13 & 8\end{pmatrix}+\ldots+\begin{pmatrix}10\\15\end{pmatrix}\begin{pmatrix}10 & 15\end{pmatrix}}{4} - cf = \begin{pmatrix}2.250 & -1.8750\\-1.8750 & 8.1875\end{pmatrix}$$

$$SS_{row-block} = \frac{\begin{pmatrix}20\\20\end{pmatrix}\begin{pmatrix}20 & 20\end{pmatrix}+\begin{pmatrix}22\\25\end{pmatrix}\begin{pmatrix}22 & 25\end{pmatrix}}{8} - cf = \begin{pmatrix}0.250 & 0.6250\\0.6250 & 1.5625\end{pmatrix}$$

$$SS_{column-block} = \frac{\begin{pmatrix}17\\26\end{pmatrix}\begin{pmatrix}17 & 26\end{pmatrix}+\begin{pmatrix}25\\19\end{pmatrix}\begin{pmatrix}25 & 19\end{pmatrix}}{8} - cf = \begin{pmatrix}4.000 & -3.500\\-3.500 & 3.0625\end{pmatrix}$$

$$SS_{row} = \frac{\begin{pmatrix}8\\10\end{pmatrix}\begin{pmatrix}8 & 10\end{pmatrix}+\ldots+\begin{pmatrix}13\\11\end{pmatrix}\begin{pmatrix}13 & 11\end{pmatrix}}{4} - cf = \begin{pmatrix}4.250 & -0.8750\\-0.8750 & 2.6875\end{pmatrix}$$

$$SS_{column} = \frac{\begin{pmatrix}8\\11\end{pmatrix}\begin{pmatrix}8 & 11\end{pmatrix}+\ldots+\begin{pmatrix}9\\11\end{pmatrix}\begin{pmatrix}9 & 11\end{pmatrix}}{4} - cf = \begin{pmatrix}10.250 & -5.6250\\-5.6250 & 6.1875\end{pmatrix}$$

$$SS_{boxes} = \frac{\begin{pmatrix}6\\12\end{pmatrix}\begin{pmatrix}6 & 12\end{pmatrix}+\ldots+\begin{pmatrix}11\\11\end{pmatrix}\begin{pmatrix}11 & 11\end{pmatrix}}{4} - cf = \begin{pmatrix}8.250 & -3.3750\\-3.3750 & 4.6875\end{pmatrix}$$

$$SS_{rowwithrowblock} = \frac{\binom{8}{10}(8 \quad 10)+\ldots+\binom{13}{11}(13 \quad 11)}{4} - \frac{\binom{20}{20}(20 \quad 20)+\binom{22}{25}(22 \quad 25)}{8}$$

$$= \begin{pmatrix} 4.000 & -1.5000 \\ -1.5000 & 1.125 \end{pmatrix}$$

$$SS_{columnwithincolumnblock} = \frac{\binom{8}{11}(8 \quad 11)+\ldots+\binom{9}{11}(9 \quad 11)}{4} - \frac{\binom{17}{26}(17 \quad 26)+\binom{25}{19}(25 \quad 19)}{8}$$

$$= \begin{pmatrix} 6.2500 & -2.125 \\ -2.125 & 3.125 \end{pmatrix}$$

$$SS_{H.boxeswithinrowblock} = \frac{\binom{6}{12}(6 \quad 12)+\ldots+\binom{11}{11}(11 \quad 11)}{4} - \frac{\binom{20}{20}(20 \quad 20)+\binom{22}{25}(22 \quad 25)}{8}$$

$$= \begin{pmatrix} 8.0000 & -4.0000 \\ -4.0000 & 3.125 \end{pmatrix}$$

$$SS_{V.boxeswithinrowblock} = \frac{\binom{6}{12}(6 \quad 12)+\ldots+\binom{11}{11}(11 \quad 11)}{4} - \frac{\binom{17}{26}(17 \quad 26)+\binom{25}{19}(25 \quad 19)}{8}$$

$$= \begin{pmatrix} 4.2500 & 0.1250 \\ 0.1250 & 1.6250 \end{pmatrix}$$

Table 5: MANOVA Table for Hui-Dong and Ru-Gen Model

Source	df	SSP
Treatments	3	$\begin{pmatrix} 2.250 & -1.8750 \\ -1.8750 & 8.1875 \end{pmatrix}$
Rows	3	$\begin{pmatrix} 4.250 & -0.8750 \\ -0.8750 & 2.6875 \end{pmatrix}$
columns	3	$\begin{pmatrix} 10.250 & -5.6250 \\ -5.6250 & 6.1875 \end{pmatrix}$
Boxes	3	$\begin{pmatrix} 8.250 & -3.3750 \\ -3.3750 & 4.6875 \end{pmatrix}$
Error	3	$\begin{pmatrix} 0.7500 & 1.6250 \\ 1.6250 & 6.6875 \end{pmatrix}$
Total	15	$\begin{pmatrix} 25.750 & -10.1250 \\ -10.1250 & 28.4375 \end{pmatrix}$

Table 6: MANOVA Table of Sudoku design of Type I

Source	df	SSP
Treatments	3	$\begin{pmatrix} 2.250 & -1.8750 \\ -1.8750 & 8.1875 \end{pmatrix}$
Row blocks	1	$\begin{pmatrix} 0.250 & 0.6250 \\ 0.6250 & 1.5625 \end{pmatrix}$
Column block	1	$\begin{pmatrix} 4.000 & -3.500 \\ -3.500 & 3.0625 \end{pmatrix}$
Rows	3	$\begin{pmatrix} 4.250 & -0.8750 \\ -0.8750 & 2.6875 \end{pmatrix}$
columns	3	$\begin{pmatrix} 10.250 & -5.6250 \\ -5.6250 & 6.1875 \end{pmatrix}$
Boxes	3	$\begin{pmatrix} 8.250 & -3.3750 \\ -3.3750 & 4.6875 \end{pmatrix}$
Error	1	$\begin{pmatrix} -3.5000 & 5.7500 \\ 5.7500 & 2.0625 \end{pmatrix}$
Total	15	$\begin{pmatrix} 25.750 & -10.1250 \\ -10.1250 & 28.4375 \end{pmatrix}$

TABLE 7: MANOVA Table of Sudoku design of Type II

Source	df	SSP
Treatments	3	$\begin{pmatrix} 2.250 & -1.8750 \\ -1.8750 & 8.1875 \end{pmatrix}$
Row blocks	1	$\begin{pmatrix} 0.250 & 0.6250 \\ 0.6250 & 1.5625 \end{pmatrix}$
Column block	1	$\begin{pmatrix} 4.000 & -3.500 \\ -3.500 & 3.0625 \end{pmatrix}$
Rows withn row block	2	$\begin{pmatrix} 4.0000 & -1.5000 \\ -1.5000 & 1.1250 \end{pmatrix}$
columns withincolumnblock	2	$\begin{pmatrix} 6.2500 & -2.1250 \\ -2.1250 & 3.1250 \end{pmatrix}$
Boxes	3	$\begin{pmatrix} 8.250 & -3.3750 \\ -3.3750 & 4.6875 \end{pmatrix}$
Error	3	$\begin{pmatrix} 0.7500 & 1.6250 \\ 1.6250 & 6.6875 \end{pmatrix}$
Total	15	$\begin{pmatrix} 25.750 & -10.1250 \\ -10.1250 & 28.4375 \end{pmatrix}$

Table 8: MANOVA Table of Sudoku design of Type IV

Source	df	SSP
Treatments	3	$\begin{pmatrix} 2.250 & -1.8750 \\ -1.8750 & 8.1875 \end{pmatrix}$
Row blocks	1	$\begin{pmatrix} 0.250 & 0.6250 \\ 0.6250 & 1.5625 \end{pmatrix}$
Column block	1	$\begin{pmatrix} 4.000 & -3.500 \\ -3.500 & 3.0625 \end{pmatrix}$
Rows within row block	2	$\begin{pmatrix} 4.0000 & -1.5000 \\ -1.5000 & 1.1250 \end{pmatrix}$
Columnwithin column block	2	$\begin{pmatrix} 6.2500 & -2.1250 \\ -2.1250 & 3.1250 \end{pmatrix}$
Boxeswithin row block	2	$\begin{pmatrix} 8.0000 & -4.0000 \\ -4.0000 & 3.1250 \end{pmatrix}$
Boxes within column block	2	$\begin{pmatrix} 4.2500 & 0.1250 \\ 0.1250 & 1.6250 \end{pmatrix}$
Error	2	$\begin{pmatrix} -3.250 & 2.1250 \\ 2.1250 & 9.7500 \end{pmatrix}$
Total	15	$\begin{pmatrix} 25.750 & -10.1250 \\ -10.1250 & 28.4375 \end{pmatrix}$

Table 9: Wilk's Test for Hui-Dong and Ru-Gen Model

Source	df	λ_1	λ_2	Λ	**α=0.05**
Treatments	3	10.9116	0.5752	0.0539	0.00953
Row	3	13.6852	0.3279	0.0513	0.00953
Column	3	38.1625	0.3506	0.0189	0.00953
Boxes	3	29.3320	0.6282	0.0202	0.00953
Error	3				
Total	15				

Not Significant at α=0.05, null hypothesis not rejecte

Table 10: Wilk's Test for MANOVA Sudoku design of Type I

Source	df	λ_1	λ_2	Λ	$\Lambda(p,k-1,g)$
Treatments	3	0.6395	-0.5786	0.6099	0.0000
Row block	1	3.0141	-2.059e-6	0.2491	0.0000
Column block	1	-9.379e-1	2.6237e-17	0.9999	0.0000
Row	3	-0.6444	0.4105	0.700	0.0000
Column	3	-1.9896	0.3965	0.7161	0.0000
Boxes	3	-1.4467	0.4681	0.6811	0.0000
Error	1				
Total	15				

Not Significant at α=0.05, null hypothesis not rejected

Table 11: Wilk's test for MANOVA Sudoku design of Type II

Source	**df**	λ_1	λ_2	Λ	$\Lambda(p,k-1,g)$
Treatments	3	10.930	0.572	0.0534	0.00953
Row block	1	1.0000	0.2763	0.3918	0.0500
Column block	1	1.7022e+1	2.2855e-16	0.1777	0.0500
Row	2	13.6027	0.0697	0.0640	0.0180
Column	2	21.1972	0.2983	0.03470	0.0180
Boxes	3	28.9348	0.3971	0.0239	0.00953
Error	3				
Total		15			

Not Significant at α=0.05, null hypothesis not rejected

Table 12: Wilk's Test for MANOVA Sudoku design of Type IV

Source	df	λ_1	λ_2	Λ	$\Lambda(p,k-1,g)$
Treatments	3	-0.6882	0.5977	0.6259	0.00028
Row block	1	1.4631	-5.2583e-18	0.4060	0.00253
Column block	1	-1.2132e+00	9.8933e-19	0.9999	0.00253
Row s within block	2	-1.2073	0.2345	0.8100	0.00064
Columnswithin block	2	-1.8735	0.2245	0.8167	0.00064
Boxes within block	2	-2.4452	0.1017	0.9077	0.00064
Boxes within block	2	-1.1496	0.1656	0.8579	0.00064
Error	2				
Total	15				

Not Significant at α=0.05, null hypothesis not rejected

Table 13: Lawley-Hotelling Test for Hui-Dong and Ru-Gen Model

Source	df	λ_1	λ_2	U^s	$\frac{v_e U^s}{v_h}$	α=0.05
Treatments	3	10.9116	0.5752	11.5752	11.4868	58.915
Row	3	13.6852	0.3279	14.0131	14.0131	58.915
Column	3	38.1625	0.3506	38.5131	38.5131	58.915
Boxes	3	29.3320	0.6282	29.9605	29.9605	58.915
Error	3					
Total	15					

Not Significant at α=0.05, null hypothesis not rejected

Table 14: Lawley-Hotelling Test for MANOVA Sudoku design of Type I

Source	df	λ_1	λ_2	U^s	$\frac{v_e U^s}{v_h}$	α=0.05
Treatments	3	0.6395	-0.5786	0.6395	0.2132	0.0000
Row block	1	3.0141	-2.059e-6	3.0141	1.0047	0.0000
Columnblock	1	-9.379e-1	2.6237e-17	0.0000	0.0000	0.0000
Row	3	-0.6444	0.4105	0.4105	0.1368	0.0000
Column	3	-1.9896	0.3965	0.3965	0.1322	0.0000
Boxes	3	-1.4467	0.4681	0.4681	0.1560	0.0000
Error	1					
Total	15					

Not Significant at α=0.05, null hypothesis not rejected

Table 15: Lawley-Hotelling test for MANOVA Sudoku design of Type II

Source	df	λ_1	λ_2	U^s	$\frac{v_e U^s}{v_h}$	α=0.05
Treatments	3	10.930	0.572	11.4882	11.4882	58.915
Row block	1	1.0000	0.2763	1.2763	3.8289	58.428
Column block	1	1.7022e+1	2.2855e-16	17.022	51.0660	58.428
Row within Boxes	2	13.6027	0.0697	13.6724	20.5086	58.915
Column within Boxes	2	21.1972	0.2983	21.4955	32.2433	58.915
Boxes	3	28.9348	0.3971	29.3319	29.3319	58.915
Error	3					
Total	15					

Not Significant at α=0.05, null hypothesis not rejected

Table 16: Lawley-Hotelling test for MANOVA Sudoku design of Type IV

Source	df	λ_1	λ_2	U^s	$\frac{v_e U^s}{v_h}$	α=0.05
Treatments	3	-0.6882	0.5977	0.5977	0.3985	10.659
Row block	1	1.4631	-5.2583e-18	1.4631	2.9262	0.0000
Column block	1	-1.2132e+00	9.8933e-19	9.8933e-19	0.0000	0.0000
Row s within block	2	-1.2073	0.2345	0.2345	0.2345	9.8591
Columnswithin block	2	-1.8735	0.2245	0.2245	0.2245	9.8591
Boxes within block	2	-2.4452	0.1017	0.1017	0.1017	9.8591
Boxes within block	2	-1.1496	0.1656	0.1659	0.1659	9.8591
Error	2					
Total	15					

Not Significant at α=0.05, null hypothesis not rejected

Table 17: Roy's test for Hui-Dong and Ru-Gen Model

Source	df	λ_1	λ_2	θ	$\theta(a,s,q,v)$
Treatments	3	10.9116	0.5752	0.9164	0.5650
Row	3	13.6852	0.3279	0.9319	0.5650
Column	3	38.1625	0.3506	0.9745	0.5650
Boxes	3	29.3320	0.6282	0.9670	0.5650
Error	3				
Total	15				

Significant at α=0.05, null hypothesis is rejected.

Table 18: Roy's test for MANOVA Sudoku design of Type I

Source	df	λ_1	λ_2	θ	$\theta(a,s,q,v)$
Treatments	3	0.6395	-0.5786	0.3901	0.5650
Row block	1	3.0141	-2.059e-6	0.7509	0.5650
Columnblock	1	-9.379e-1	2.6237e-17	0.0000	0.5650
Row	3	-0.6444	0.4105	0.2910	0.5650
Column	3	-1.9896	0.3965	0.2839	0.5650
Boxes	3	-1.4467	0.4681	0.3188	0.5650
Error	1				
Total	15				

Not significant at α=0.05, null hypothesis not rejected

Table 19: Roy's test for MANOVA Sudoku design of Type II

Source	df	λ_1	λ_2	θ	$\theta(\alpha, s, q, v)$
Treatments	3	10.930	0.572	0.9161	0.5650
Row block	1	1.0000	0.2763	0.5000	0.5650
Column block	1	1.7022e+1	2.2855e-16	0.9445	0.5650
Row within Boxes	2	13.6027	0.0697	0.9315	0.5650
Column within Boxes	2	21.1972	0.2983	0.9545	0.5650
Boxes	3	28.9348	0.3971	0.9666	0.5650
Error	3				
Total	15				

Significant at α=0.05, null hypothesis is rejected

Table 20: Roy's test for MANOVA Sudoku design of Type IV

Source	df	λ_1	λ_2	θ	$\theta(\alpha, s, q, v)$
Treatments	3	-0.6882	0.5977	0.3741	0.5650
Row block	1	1.4631	-5.2583e-18	0.5940	0.5650
Column block	1	-1.2132e+00	9.8933e-19	0.0000	0.5650
Row s within block	2	-1.2073	0.2345	0.1899	0.5650
Columnswithin block	2	-1.8735	0.2245	0.817	0.5650
Boxes within block	2	-2.4452	0.1017	0.0923	0.5650
Boxes within block	2	-1.1496	0.1656	0.1421	0.5650
Error	2				
Total	15				

Not Significant at α=0.05, null hypothesis not rejected

Table 21: Pillai test for Hui-Dong and Ru-Gen Model

Source	df	λ_1	λ_2	V^s	$\theta(\alpha, s, q, v)$
Treatments	3	10.9116	0.5752	1.2812	1.536
Row	3	13.6852	0.3279	1.1788	1.536
Column	3	38.1625	0.3506	1.2341	1.536
Boxes	3	29.3320	0.6282	1.3530	1.536
Error	3				
Total	15				

Not Significant at α=0.05, null hypothesis not rejected

Table 22: Pillai test for MANOVA Sudoku design of Type I

Source	df	λ_1	λ_2	V^s	$\theta(\alpha, s, q, v)$
Treatments	3	0.6395	-0.5786	0.3901	1.536
Row block	1	3.0141	-2.059e-6	0.7509	1.536
Columnblock	1	-9.379e-1	2.6237e-17	0.0000	1.536
Row	3	-0.6444	0.4105	0.2910	1.536
Column	3	-1.9896	0.3965	0.2839	1.536
Boxes	3	-1.4467	0.4681	0.3188	1.536
Error	1				
Total	15				

Not Significant at α=0.05, null hypothesis not rejected

Table 23: Pillai test for MANOVA Sudoku design of Type II

Source	df	λ_1	λ_2	V^s	$\theta(\alpha, s, q, v)$
Treatments	3	10.930	0.572	1.2811	1.536
Row block	1	1.0000	0.2763	0.7189	1.536
olumn block	1	1.7022e+1	2.2855e-16	0.8223	1.536
Row within Boxes	2	13.6027	0.0697	0.9967	1.536
Column within Boxes	2	21.1972	0.2983	1.1770	1.536
Boxes	3	28.9348	0.3971	1.2508	1.536
Error	3				
Total	15				

Not Significant at α=0.05, null hypothesis not rejected

Table 24: Pillai test for MANOVA Sudoku design of Type IV

Source	df	λ_1	λ_2	V^s	$\theta(\alpha, s, q, v)$
Treatments	3	-0.6882	0.5977	0.3741	1.536
Row block	1	1.4631	-5.2583e-18	0.5940	1.536
Column block	1	-1.2132e+00	9.8933e-19	0.0000	1.536
Row s within block	2	-1.2073	0.2345	0.1899	1.536
Columnswithin block	2	-1.8735	0.2245	0.1833	1.536
Boxes within block	2	-2.4452	0.1017	0.0923	1.536
Boxes within block	2	-1.1496	0.1656	0.1420	1.536
Error	2				
Total	15				

Not significant at α=0.05, null hypothesis not rejected

Discussion

This research paper aimed at modifying existing univariate Sudoku square design models to a multivariate case. However, the study proposed procedures of obtaining multivariate analysis of variance for the models and also procedures for calculating the sums of square and products using numerical example. The hypothetical data used for this study, assumed to have multivariate normal with p-vector mean and constant variance-covariance matrix (sigma). The SSP on the MANOVA tables contain matrices of order 2, because sample size of the data used is 2. The main diagonal is the sum of squares while off the diagonal is the sum of products. The results of significant tests show that Wilk's Lambda, Pillai and Lawley-Hotteling, test no significant at α=0.05 for all the effects in all the models proposed. However, Roy,s largest root showed significant effect for all effects in the Hui-Dong and Ru-Gen model and model II of Subramani and Ponnuswamy.

It was observed that three of the univariate Sudoku models suggested by Subramani and Ponnuswamy (2009) were modified in this research, Type III was not modified. The reason is, owing to the fact that the available hypothetical data was insufficient to carry out MANOVA for the model.

Conclusion

This paper modified the existing univariate Sudoku square models suggested by Hui-Dong and Ru-Gen (2008) and Subramani and Ponnuswamy (2009) to cater for more than one dependent variables. It also revealed the procedures for manual computation of sum of squares and products of Sudoku square design when the dependent variables are more than one (multivariate).The generalized linear model for Sudoku square models was proposed and MANOVA tests of significance were carried out using four different tests at α=0.05.

This paper recommended that higher order of Sudoku square design should be used to avoid some models failing due to insufficient data, as regarding the case of model III, suggested by Subramani and Ponnuswamy (2009) that failed under Sudoku square of order 4. Further, the use of four multivariate tests to test significance of effects should be encouraged for these proposed multivariate Sudoku models as each of these tests has the same probability of rejecting null hypothesis and however, at times in a given data set conclusions might be differed even when null hypothesis is true.

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ANALYTICAL SOLUTION OF TYPHOID FEVER INFECTION VIA HOMOTOPY PERTURBATION METHOD (HPM)

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Abstract
In this paper, a deterministic mathematical model of typhoid fever infection was formulated with a control strategies. We find the analytical solution of the proposed model by Homotopy perturbation method which is one of the best method for finding the solution of the nonlinear problem to obtain the approximate solution of the model. The results are presented graphically and discussed. It is discovered that the epidemic is sustained in the population. Implications of these results indicate that treatment sustain the carrier infectives who in turn sustains the epidemic in the population in the long run.

Keywords: Homotopy Perturbation method, Typhoid fever, model, Simulations

Introduction

Typhoid is a major public health concern in tropical developing countries, especially in areas where access to clean water and other sanitation measures are limited (Crump & Mintz 2010; Mutua, Wang, & Vaidya, 2015; Pitzer et al, 2015). Typhoid fever has complex pathogenesis and manifests as an acute febrile disease, with relatively long incubation period that involves the transmigration of the microorganism through the Peyer's patch, localized multiplication in the mesenteric lymph nodes, and subsequent spread to the liver and spleen prior to showing clinical symptoms (Thompson et al, 2009). It is a serious life-threatening infection characterised by false diagnosis due to similar signs and symptoms with malaria, which leads to improper controls and management of the disease. Despite extensive work on typhoid, not much is understood on the biology of the human-adapted bacterial pathogen and the complexity of the disease in endemic areas, especially in Africa (Wain, et al,2015). Globally, the burden of the disease is estimated at 21 million cases and 222000 deaths annually with high rates reported among children and adolescents in South and Eastern Asia and uncertain in Africa (Date, Bentsi-Enchill, Marks, & Fox, 2015; Mogasale et al, 2014; Qamar, Azmatullah, & Bhutta, 2015). The symptoms are alleviated with antibiotic medications, however, aproportion of people treated for typhoid fever usually experience relapse, after a week of antibiotic treatment with symptoms which are milder and last for a shorter time compared with the original illness, requiring further treatment with antibiotics (Basnyat, 2007; Zaki, 2011). Typhoid fever maybe prevented using vaccines, even though repeated mass vaccinations at intervals of 5 years interval may reduce the disease incidence, small gains re-observed at each subsequent vaccination (Mushayabasa, Bhunu, & Mhlanga, 2014). The dynamics of typhoid fever involve multiple interactions between the human host, pathogen and environment, contributing to both direct human-to-human and indirect environment-to-human transmission pathways (Gonzalez-Guzman, 1989; Pitzer et al,2015). Typhoid fever produces long-term asymptomatic carriers which play a pivotal role in the disease transmission.

In order to gain in-depth understanding of the complex dynamics of typhoid fever a number of studies have been conducted and published. Cvjetanovic et al. (Mushayabasa, Bhunu, & Mhlanga, 2014). Constructed an epidemic model for typhoid fever in a stable population to study the transmission of infection at different levels of endemicity. Mushayabasa et al.

(Gonzalez-Guzman, 1989). Developed and analysed a deterministic mathematical model for assessment of the impact of treatment and educational campaigns on controlling typhoid out-break in Zimbabwe. Date et al. (Date, Bentsi-Enchill, Marks, & Fox, 2015). Reviewed various vaccination strategies using current typhoid vaccines to assess the rationale, acceptability, effectiveness, impact and implementation lessons in order to inform future public health typhoid control strategies. Watson and Edmunds (Mushayabasa, Bhunu, & Mhlanga, 2014). Carried out an intensive review of typhoid fever transmission dynamics models and economic evaluation of vaccination. Clinicians, microbiologists, modellers, and epidemiologists worldwide need full understanding and knowledge of typhoid fever to effectively control and manage the disease (Wain et al,2015).

The Homotopy Analysis Method is one of the well-known methods to solve the linear and non-linear equations. In the last decade, the idea of Homotopy was combined with perturbation. The fundamental work was done by (He 2000). This method involves a free parameter, whose suitable choice results into fast convergence. Homotopy Perturbation Method and its application was introduced by (He, 2000; He, 2006; He, 2008; He, 2009). These methods are independent of the assumption of small parameter as well as they cover all the advantages of the perturbation method. Mohammad *et al.,* (2014) developed a model of SIR by homotopy perturbation method (HPM), the models were solved by non-standard finite difference method (NSFD), Runge-Kutta order 4 (RK4) and compared the HPM solution with NSFD and RK4, it found that the HPM solution have a good agreement with other standard method of NSFD and RK4 (Muhammad, Syed, Sher, Saeed, & Farooq, 2014).

In this paper, we consider the model presented in (Moatlhodi, & Gosalamang, 2016) by applying the Homotopy perturbation method, to find the approximate solution. First, we formulate our problem and then apply the HPM to find the analytical solution.

Materials and Methods

Following (Moatlhodi, & Gosalamang, 2016), the equations describing typhoid fever epidemics are:

$$\frac{dS}{dt} = \Lambda - \frac{c\beta(I + k_1 I_c + k_2 T)}{N} S - \mu S \quad (1)$$

$$\frac{dI}{dt} = \frac{c\beta\rho(I + k_1 I_c + k_2 T)}{N} S + \alpha I_c - (\mu + \sigma + \delta_1) I \quad (2)$$

$$\frac{dI_c}{dt} = \frac{(1-\rho)c\beta(I + k_1 I_c + k_2 T)}{N} S + \tau T - (\mu + \alpha) I_c \quad (3)$$

$$\frac{dT}{dt} = \sigma I - (\mu + \gamma + \tau + \delta_2) T \quad (4)$$

$$\frac{dR}{dt} = \gamma T - \mu R \quad (5)$$

$$N(t) = S(t) + I(t) + I_c + T(t) + R(t) \quad (6)$$

As initial condition based on our assumptions, we choose

$$S(0) = a_0, I(0) = b_0, I_c(0) = c_0, T(0) = d_0, R(0) = e_0 \quad (7)$$

Where:

Variable	Parameters
$S(t)$ - Susceptible human	Λ - Recruitment rate
$I(t)$ -Infectives human	μ - per capital death rate
$I_c(t)$ - Carriers human	δ_1, δ_2 - Disease-induced deaths
$T(t)$ - Treated infectives	c - effective contacts
$R(t)$ - Recovered human	β - Rate of transmission
	α - Progression to symptomatic state
	γ - Rate of recovery from treatment
	ρ - New infections becoming carriers
	σ - Rate of treatment
	τ - Proportion of treated individuals
	k_1, k_2 - Modification parameters

Method of Solution

Solution of the Model Using Homotopy perturbation Method (HPM)

Homotopy perturbation method (HPM) was developed by [16]. The HPM provides solution to various linear and nonlinear differential equations. The basic ideas of the method are by considering the following nonlinear differential equation:

$$A(U) - f(r) = 0, r \in \Omega \quad (8)$$

With the boundary condition

$$B(u, \frac{\partial u}{\partial n}) = 0, \ r \in \Gamma \quad (9)$$

Where A is the general differential operator, B the boundary operator, $f(r)$ is the analytical function and Γ is the boundary of the domain Ω. The A operator can be divided into two major part L and N been the linear and nonlinear component respectively. Equation (8) can be writtenas follows:

$$L(u) + N(u) = f(r), \ r \in \Omega \quad (10)$$

The HPM is composed as follows:

$$H(V, h) = (1 - p)[L(V) - L(U_o)] + p[A(V) - f(r)] = 0 \quad (11)$$

where $V(r, P) : \Omega \in [0,1] \to R$ (12)

From equation (10), $P \in [0,1]$ is an embedded parameter and U_0 is the approximation that satisfies the boundary condition. The solution to equation (11) can be assumed as power series in h as follows:

$$V = V_0 + p^1 V_1 + p^2 V_2 + \ldots \quad (13)$$

$$U = v_0 + p^1 v_1 + p^2 v_2 + \ldots \quad (14)$$

$$p \to 1$$

The rate of convergence majorly depends on the nonlinear operator $A(V)$

From equation (1) – (5), we have

$$\frac{dS}{dt} = \Lambda - \frac{c\beta(I + k_1 I_c + k_2 T)}{N} S - \mu S \quad (15)$$

$$\frac{dI}{dt} = \frac{c\beta\rho(I + k_1 I_c + k_2 T)}{N} S + \alpha I_c - k_3 I \quad (16)$$

$$\frac{dI_c}{dt} = \frac{(1-\rho)c\beta(I + k_1 I_c + k_2 T)}{N} S + \tau T - k_4 I_c \quad (17)$$

$$\frac{dT}{dt} = \sigma I - k_5 T \quad (18)$$

$$\frac{dR}{dt} = \gamma T - \mu R \quad (19)$$

where

$$k_3 = (\mu + \sigma + \delta_1)$$

$$k_4 = (\mu + \alpha)$$

$$k_5 = (\mu + \gamma + \tau + \delta_2)$$

With the following initial conditions $S(0) = a_0, I(0) = b_0, I_c(0) = c_0, T(0) = d_0, R(0) = e_0$

Let

$$S = S_0 + pS_1 + p^2 N_2 + \ldots \quad (20)$$

$$I = I_0 + pI_1 + p^2 I_2 + \ldots \quad (21)$$

$$I_c = I_{c0} + pI_{c1} + p^2 I_{c2} + .. \quad (22)$$

$$T = T_0 + pT_1 + p^2 T_2 + \ldots \quad (23)$$

$$R = R_0 + pR_1 + p^2 R_2 + \ldots \quad (24)$$

Appling Homotopy Perturbation Method (HPM) to equations (15) - (19) using equation (20) - (24), we obtain the orders of p as follows:

$$p^0 : \frac{dS_0}{dt} = 0, \frac{dI_0}{dt} = 0 \; \frac{dI_{c0}}{dt} = 0, \frac{dT_0}{dt} = 0, \frac{dR_0}{dt} = 0 \quad (25)$$

$$p^1 : \frac{dS_1}{dt} = \Lambda - \frac{c\beta}{N_0}(I_0 S_0 + k_1 I_{c0} S_0 - k_2 T_0 S_0) - \mu S_0 \quad (26)$$

$$\frac{dI_1}{dt} = \frac{\rho c\beta}{N_0}(I_0 S_0 + k_1 I_{c0} S_0 - k_2 T_0 S_0) + \alpha I_{c0} + k_3 I_0 \quad (27)$$

$$\frac{dI_{c1}}{dt} = \frac{(1-\rho)c\beta}{N_0}(I_0 S_0 + k_1 I_{c_0} S_0 - k_2 T_0 S_0) + \tau T_0 - k_4 I_{c0} \quad (28)$$

$$\frac{dT}{dt} = \alpha I_o - k_5 T_0 \quad (29)$$

$$\frac{dR}{dt} = \gamma T_0 - \mu R_0 \quad (30)$$

$$p^2 : \frac{dS_2}{dt} = -\frac{c\beta}{N_1}\{(I_0 S_1 + I_1 S_0) + k_1(I_{c0} S_1 + I_{c1} S_0) + k_2(T_0 S_1 + T_1 S_0)\} - \mu S_1 \quad (31)$$

$$\frac{dI_2}{dt} = \frac{c\beta}{N_1}\{(I_0 S_1 + I_1 S_0) + k_1(I_{c0} S_1 + I_{c1} S_0) + k_2(T_0 S_1 + T_1 S_0)\} + \alpha I_{c1} - k_3 I_1 \quad (32)$$

$$\frac{dI_{c2}}{dt} = \frac{c\beta}{N_1}\{(I_0 S_1 + I_1 S_0) + k_1(I_{c0} S_1 + I_{c1} S_0) + k_2(T_0 S_1 + T_1 S_0)\} + \tau T_1 - k_4 I_{c1} \quad (33)$$

$$\frac{dT_2}{dt} = \sigma I_1 - k_5 T_1 \quad (34)$$

$$\frac{dR_2}{dt} = \gamma T_1 - \mu R_1 \quad (35)$$

Solving equation (25) – (35) using the initial condition and collecting the coefficient

of power of p by expansion, we obtain:

$$p^0 : S_0 = a_0, I_0 = b_0, I_{c0} = c_0, T_0 = d_0, and \;\; R_0 = e_0 \tag{36}$$

$$p^1 : S_1 = \{\Lambda - \frac{c\beta}{N_0}[b_0a_0 + k_1c_0a_0 + k_2d_0a_0] - \mu a_0\}t \tag{37}$$

$$I_1 = \{\frac{\rho c\beta}{N_0}[b_0a_0 + k_1c_0a_0 + k_2d_0a_0] + \alpha c_0 - k_3b_0\}t \tag{38}$$

$$I_{c1} = \{\frac{(1-\rho)c\beta}{N_0}[b_0a_0 + k_1c_0a_0 + k_2d_0a_0] + \tau d_0 - k_3c_0\}t \tag{39}$$

$$T_1 = \{\sigma b_0 - k_5d_0\}t \tag{40}$$

$$R_1 = \{\gamma d_0 - \mu e_0\}t \tag{41}$$

$$p^2 : S_2 = \frac{1}{2}t^2\{-\frac{c\beta}{N1}[(b_0a_1 + b_1a_0) + k_1(c_0a_1 + c_1a_0) + k_2(d_0a_1 + d_1a_0)] - \mu a_1\} \tag{42}$$

$$I_2 = \frac{1}{2}t^2\{\frac{\rho c\beta}{N1}[(b_0a_1 + b_1a_0) + k_1(c_0a_1 + c_1a_0) + k_2(d_0a_1 + d_1a_0)] + \alpha c_1 - k_3b_1\} \tag{43}$$

$$I_{c2} = \frac{1}{2}t^2\{\frac{(1-\rho)c\beta}{N1}[(b_0a_1 + b_1a_0) + k_1(c_0a_1 + c_1a_0) + k_2(d_0a_1 + d_1a_0)] + \tau d_1 - k_3c_1\} \tag{44}$$

$$T_2 = \frac{1}{2}t^2\{\sigma b_1 - k_5d_1\} \tag{45}$$

$$R_2 = \frac{1}{2}t^2\{\gamma d_1 - \mu e_1\} \tag{46}$$

Substituting the values above into the series in equation (20) - (24) taking the limit as $p \to 1$, we obtained the result as follows:

$$S(t) = a_0 + \{\Lambda - \frac{c\beta}{N_0}[b_0a_0 + k_1c_0a_0 + k_2d_0a_0] - \mu a_0\}t + \frac{1}{2}t^2\{-\frac{c\beta}{N1}[(b_0a_1 + b_1a_0) + k_1(c_0a_1 + c_1a_0) + k_2(d_0a_1 + d_1a_0)] - \mu a_1\} \tag{47}$$

$$I(t) = b_0 + \{\frac{\rho c\beta}{N_0}[b_0a_0 + k_1c_0a_0 + k_2d_0a_0] + \alpha c_0 - k_3b_0\}t + \frac{1}{2}t^2\{\frac{\rho c\beta}{N1}[(b_0a_1 + b_1a_0) + k_1(c_0a_1 + c_1a_0) + k_2(d_0a_1 + d_1a_0)] + \alpha c_1 - k_3b_1\} \tag{48}$$

$$I_c(t) = c_0 + \{\frac{(1-\rho)c\beta}{N_0}[b_0a_0 + k_1c_0a_0 + k_2d_0a_0] + \tau d_0 - k_3c_0\}t + \frac{1}{2}t^2\{\frac{(1-\rho)c\beta}{N1}[(b_0a_1 + b_1a_0) + k_1(c_0a_1 + c_1a_0) + k_2(d_0a_1 + d_1a_0)] + \tau d_1 - k_3c_1\} \tag{49}$$

$$T(t) = d_0 + \{\sigma b_0 - k_5d_0\}t + \frac{1}{2}t^2\{\sigma b_1 - k_5d_1\} \tag{50}$$

$$R(t) = e_0 + \{\gamma d_0 - \mu e_0\}t + \frac{1}{2}t^2\{\gamma d_1 - \mu e_1\} \quad (51)$$

Numerical Simulations

The simulations were carried out using the following variables and parameters in the table below for initial conditions at time (t). Computations were run in maple 17 software for investigation. Here we investigate the analytical solution of the model equation (1) to (6), using data from table below. We consider various treatment scenarios to investigate the effect of treatment in reducing the burden of the disease and evolution of carriers. We provide the graphs of our solutions to the problem under consideration. The discussions are presented after the graphs

Table 1: Typhoid Model Parameter and their Interpretations

Description	Parameter	Value	Citation
Recruitment rate	Λ	31.3-55/100	[Pitzer, *et al* (2014)]
Per capital death rate	μ	7.7-27.8/1000	[Pitzer, *et al* (2014)]
Disease-induced deaths	δ_1, δ_2	0.03-0.02-0.001	[Pitzer, *et al* (2014)]
Effective contacts	c	10	[Ghosh, *et al* (2004)]
Rate of transmission	β	0.000197/day	[Mushayabasa, (2011)]
Progression to symptomatic state	α	1/90	[Cvjetanovic, *et al* (1971)]
Rate of recovery from treatment	γ	0.002485/day	
New infections becoming carriers	ρ	0.003-0.80	[Pitzer, *et al* (2014)]
Rate of treatment	σ	0.19-0.8	Varied
Proportion of treated individuals	τ	1/18	[Cvjetanovic, *et al* (1971)]
Modification parameters	k_1, k_2	1-1.2	Varied

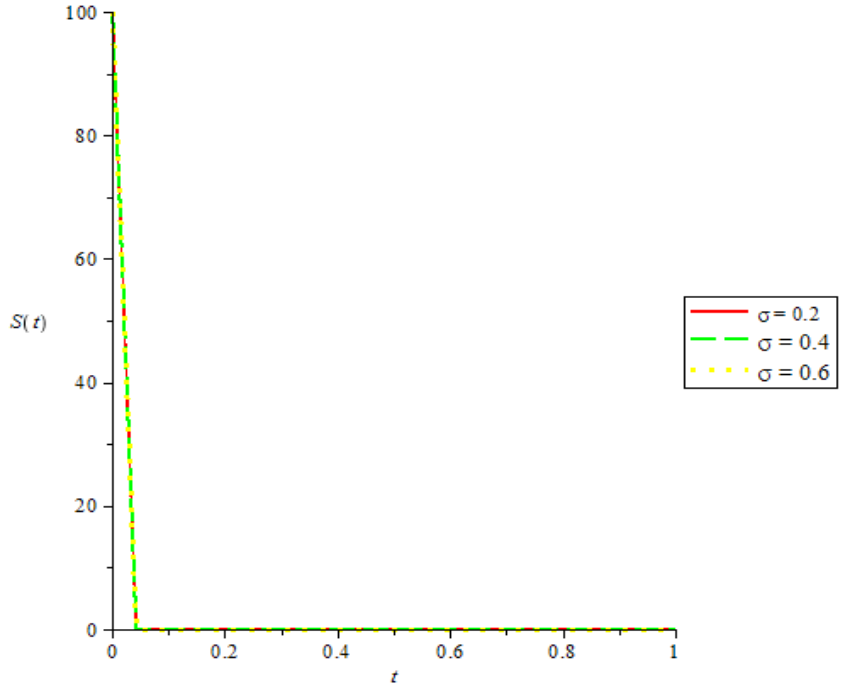

Figure 1: $S(t)$ versus time t for various value of σ at Λ=55/1000, $\delta_1 = 0.001$, $\delta_2 = 0.000247$, $\beta = 0.125$, $\gamma = 0.01$, $\rho = 0.8$, $\mu = 0.02$, $\alpha = 0.45$, $\tau = 0.056$, $k_2 = 1$, $k_1 = 1.2$,

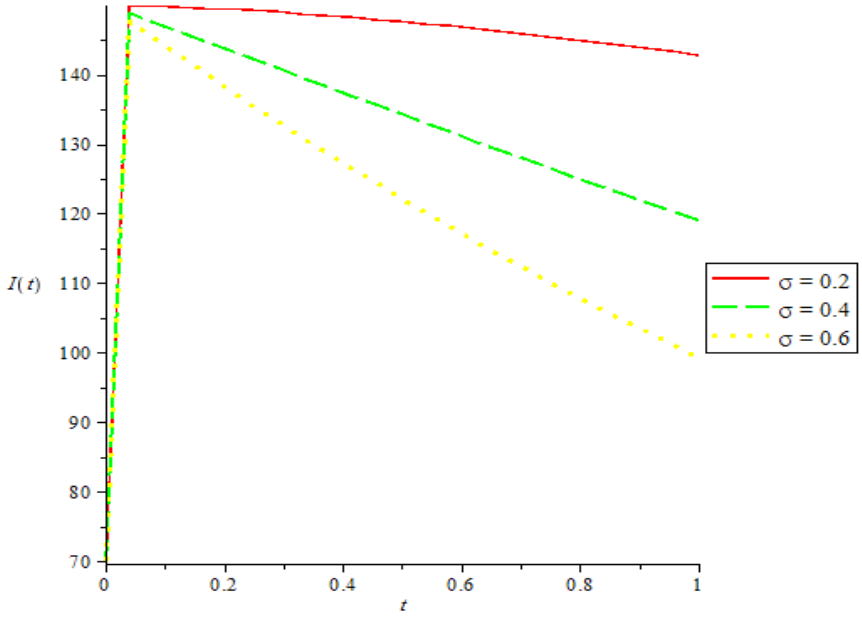

Figure 2: I(t) versus time t for various value of σ at Λ=55/1000, $\delta_1 = 0.001$, $\delta_2 = 0.000247$, $\beta = 0.125$, $\gamma = 0.01$, $\rho = 0.8$, $\mu = 0.02$, $\alpha = 0.45$, $\tau = 0.056$, $k_2 = 1$, $k_1 = 1.2$,

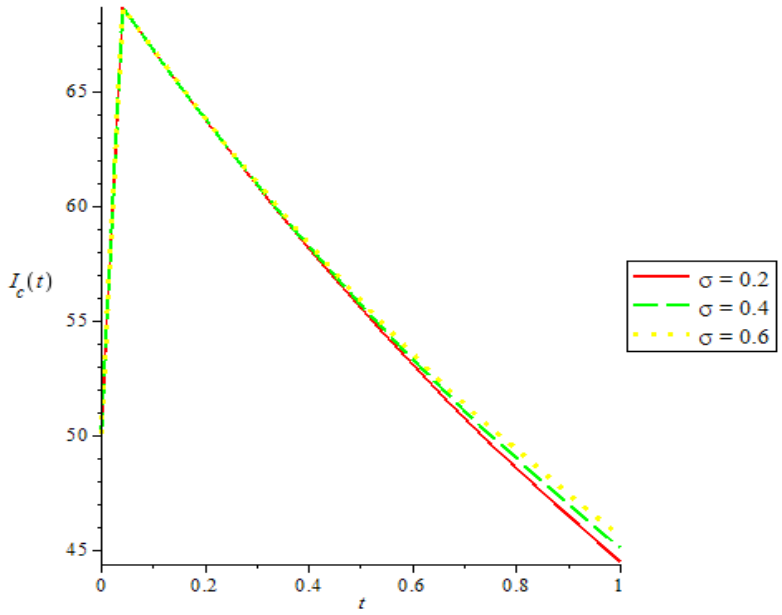

Figure 3: I_C(t) versus time t for various value of σ at Λ=55/1000, $\delta_1 = 0.001$, $\delta_2 = 0.000247$, $\beta = 0.125$, $\gamma = 0.01$, $\rho = 0.8$, $\mu = 0.02$, $\alpha = 0.45$, $\tau = 0.056$, $k_2 = 1$, $k_1 = 1.2$,

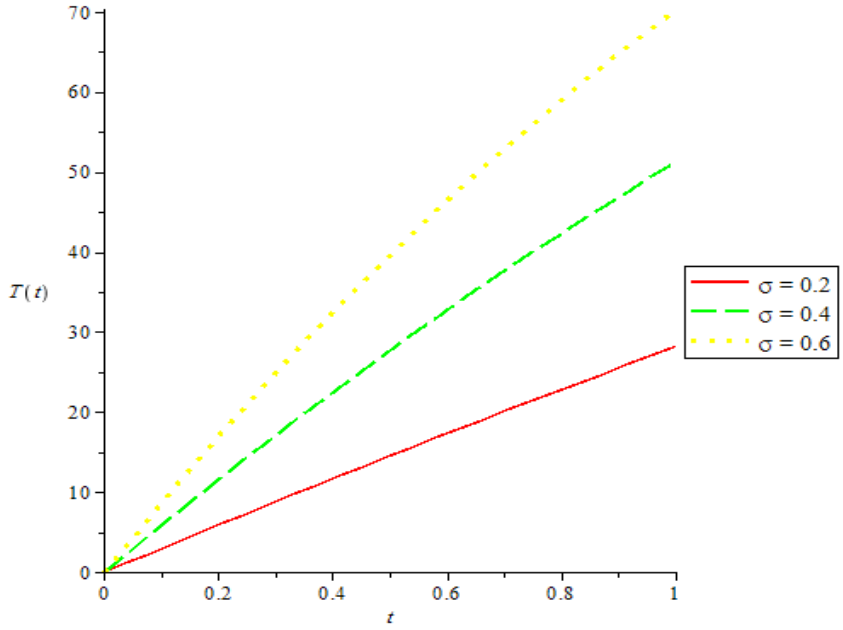

Figure 4: T(t) versus time t for various value of σ at Λ=55/1000, $\delta_1 = 0.001$, $\delta_2 = 0.000247$, $\beta = 0.125$, $\gamma = 0.01$, $\rho = 0.8$, $\mu = 0.02$, $\alpha = 0.45$, $\tau = 0.056$, $k_2 = 1$, $k_1 = 1.2$,

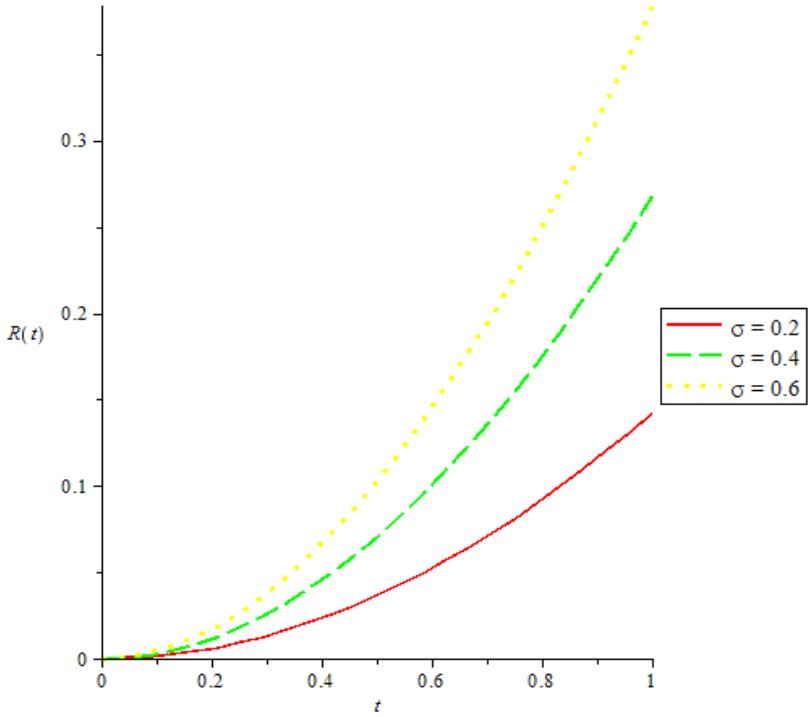

Figure 5: R (t) versus time t for various value of σ at Λ=55/1000, $\delta_1 = 0.001$, $\delta_2 = 0.000247$, $\beta = 0.125$, $\gamma = 0.01$, $\rho = 0.8$, $\mu = 0.02$, $\alpha = 0.45$, $\tau = 0.056$, $k_2 = 1$, $k_1 = 1.2$,

Results and Discussion

Numerical simulations suggested that increasing treatment sustains the typhoid epidemic in the population. Implications of this result points to an added effect from carriers evolving from treatment relapse. The dependence of modification transmission parameter k_2 on

treated population provides insight in the role of treatment in the transmission dynamics of the disease. Due to complexity of the model closed form solutions of the population density dependent transmission rate could not be obtained. The study suggest development and implementation of preventive and treatment strategies which can reduce the burden of carriers in the population. Sensitive algorithms for case detection of infectives, especially carriers will play a critical role in reducing the burden of typhoid disease. Epidemic trends guide allocation of resources, targeted design of control strategies and surveillance or improved techniques for data collection. Even though, this study provides insight on the transmission dynamics of typhoid infection. The dependence of infection parameters in the state variables seemed to suggest crucial dynamics appropriate to describe realistic behaviour of diseases.

Conclusion

We presented a deterministic model for typhoid fever transmission model with treatment. The study revealed through simulations that the epidemic is sustained in the population. Implications of these results indicate that treatment sustain the carrier infectives who in turn sustains the epidemic in the population in the long run. Our paper is hypothetical and requires detailed study involving sensitivity analysis and parameter estimations to improve model predictions.

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CONVERGENCE OF REFINED S-ITERATION IN BANACH SPACE

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Abstract
The convergence of a sequence generated by a refined S-iteration scheme for finding a common fixed point of non-expansive mappings in a Banach space are obtained. Numerical example to validate our results is generated.

Keywords: *Convergence, Iterative Scheme, Banach Space, Fixed point & Operator.*

Introduction

There are several fixed point iteration methods and several fixed point theorems underlying them. One of the earliest uses was picard iteration method for proving existence of solutions of Ordinary Differential Equation. It is based on the "Banach fixed point theorem" though Banach was not born yet when Picard discovered it.

The origin of fixed point theory lies in the method of successive approximation used for proving existence of solutions of differential equations introduced independently by Joseph Liouville in 1837 and Charles Emile Picard in 1890 (see Mann; 1953; Xue & Zhang, 2013). But formally it was started in the beginning of twentieth century as an important part of analysis. The abstraction of this classical is the pioneering work of the great Polish Mathematician Stefan Banach published in 1922 which provides a constructive method to find the fixed point of a map. Fixed point iterative procedure are designed to be applied in solving equations arising in physical formulation but there is no systematic study of numerical aspects of these iterative procedures. In computational Mathematics, it is of interest to know which of the given iterative procedures converges faster to a desire solution, commonly known as rate of convergence. Rhoades (1995) compared the Mann and Ishikawa iterative procedures concerning their rate of convergence. He illustrated the difference in the rate of convergence for increasing and decreasing functions. Indeed, he used computer programs, perhaps for the first time to compare the Mann and Ishikawa iteration through examples.

Iterative methods are often the only choice for non linear equations. however, iterative methods are often useful even for linear problems involving a large number of variables where direct method would be prohibitively expensive even with the best available computing power. However the iterative scheme adopted in this paper work are Ishikawa, Picard-Mann, S-iteration and Refined S-iteration [see Zamfirescu, 1972), Liu, 1995; Rauf et. al. (2017)].

The aim of this paper is to establish the strong convergence, convergence rate of iterative schemes with errors using Zamfirescu operator in Banach spaces. The main objectives are to

find a common iterative scheme for some iterative algorithms, obtain the uniqueness of the iterative schemes.

In particular, we adjusted Picard-Mann iteration in form of S-iteration and prove the strong convergence of a sequence generated by the adapted S-iteration scheme with errors in a Banach space. Numerical example is used to validate the results.

Some Special Iterations

Picard Iteration

The Picard iteration process is defined by the sequence

$$x_{n+1} = Tx_n, \qquad n \geq 0 \tag{2.1}$$

and the concept of Picard iteration process with error is defined as follows

$$x_{n+1} = Tx_n + u_n, \qquad n \geq 0 \tag{2.2}$$

where u_n satisfy

$$\sum_{n=1}^{\infty} \| u_n \| < \infty \tag{2.3}$$

Picard-Mann Iteration

Picard-Mann iteration is given by

$$x_{n+1} = Ty_n$$
$$y_n = (1-\alpha_n)x_n + \alpha_n Tx_n, \qquad n \geq 0 \tag{2.4}$$

where α_n is a sequence in $[0,1]$ with $\sum \alpha_n = \infty$

while the Picard-Mann iteration process with errors is given as

$$x_{n+1} = Ty_n + e_n$$

,

$$y_n = (1-\alpha_n)x_n + \alpha_n Tx_n + f_n, \qquad n \geq 0 \tag{2.5}$$

where e_n and f_n satisfy

$$\sum_{n=1}^{\infty} \| f_n \| < \infty$$

and

$$\sum_{n=1}^{\infty} \| \infty \| < \infty$$

Ishikawa Iteration

Ishikawa iteration defined another iteration process given by the sequence

$$x_{n+1} = (1-\alpha_n)y_n + \alpha_n Tx_n$$

$$y_n = (1-\beta_n)x_n + \beta_n Tx_n, \qquad n \geq 0 \tag{2.6}$$

where α_n and β_n are sequence in $[0,1]$

The Ishikawa iteration is a double Mann iteration and has better approximation than Mann iteration.

The Ishikawa iteration with errors is given as:

$$x_{n+1} = (1-\alpha_n)y_n + \alpha_n Tx_n + e_n$$

$$y_n = (1-\beta_n)x_n + \beta_n Tx_n + f_n, \qquad n \geq 0 \tag{2.7}$$

where e_n and f_n satisfy

$\sum_{n=1}^{\infty} \| e_n \| < \infty$ and $\sum_{n=1}^{\infty} \| f_n \| < \infty$ respectively.

S-Iteration

In attempt to reduce computational cost, Agarwal defined another iteration called S-iteration which is independent of Mann and Ishikawa iteration and it is defined by the sequence:

$$x_{n+1} = (1-\alpha_n)Tx_n + \alpha_n Ty_n$$

$$y_n = (1-\beta_n)x_n + \beta_n Tx_n, \qquad n \geq 0 \tag{2.8}$$

where α_n and β_n are sequence in $[0,1]$.

The S-iteration with errors can be given as

$$x_{n+1} = (1-\alpha_n)Tx_n + \alpha_n Ty_n + e_n$$

$$y_n = (1-\beta_n)x_n + \beta_n Tx_n + f_n, n \geq 0 \tag{2.9}$$

where e_n and f_n satisfy

$$\sum_{n=1}^{\infty} \| f_n \| < \infty$$

and

$$\sum_{n=1}^{\infty} \| \infty \| < \infty$$

See, Agarwa et. al (2007).

Some Important Terms

Fixed point: Fixed point of a function is an element of the the function's domain that is mapped to itself by the function. that is to say, x is a fixed point of the function $f(x)$ if and only if $f(x) = x$.

Fixed point iteration: Given a function f defined on the real numbers with real values and given a point x_0 in the domain of f, the fixed point iteration is

$$x_{n+1} = f(x_n)$$

, $n = 0,1,2....$ which gives rise to the sequence x_0, x_1, x_2 $\cdots$ which is hoped to converge to a point x

Contraction mapping: A contraction mapping on a metric space (M,d) is a function f from M to itself, with the property that there is some non-negative real number $0 \leq k < 1$ such that for all x and y in M,

$$d(f(x), f(y)) \leq kd(x, y)$$

The smallest value of k is called the Lipschitz constant of f. Contractive maps are sometimes called lipschitizian maps. if the above condition is instead satisfied for $k \leq 1$, then the mapping is said to be a non-expansive map.

Main Results

Banach proved the convergence of Picard iteration process

$$x_{n+1} = Tx_n, \qquad n \geq 0$$

with the aid of the following contractive mapping.

$$d(Tx, Ty) \leq ad(x, y) \tag{3.1}$$

where $T : X \to X$. (X, d) is a metric space, $a \in (0,1)$ and $x, y \in X$. Banach's theorem is given as follow:

Theorem 3.1: *Let (X, d) be a metric space and $T : X \to X$ be a contraction map on X. Then T has a unique fixed point $x \in X$.*

When condition of the contraction mapping is weaker, Picard iteration will no longer converge to a fixed point. Hence, other iteration such as Mann iteration, Picard-Mann iteration, Ishikawa iteration, Thiawan iteration and S-iteration would be considered.

The most generalized operator used to approximate fixed point is the one proved by Zamfirescu. The Zamfirescu operator was obtain from the Banach, Kannan and Chatterjea contractive mappings [See, Kannan (1968)] as follows: The operator T is called a Kannan mapping if there exist $b \in (0, \frac{1}{2})$ such that

$$d(Tx, Ty) \leq b[d(x, Tx) + d(y, Ty)] \quad \forall\, x, y \in X \tag{3.2}$$

Another similar definition due to Chatterjea mapping is as follows:

there exists $c \in (0, \frac{1}{2})$ such that

$$d(Tx, Ty) \leq c[d(x, Ty) + d(y, Tx)] \quad \forall\, x, y \in X. \tag{3.3}$$

By combining (3.1), (3.2) and (3.3) conditions we have the Zamfirescu operator given, for $x, y \in X$ by

$$Z_1 : d(Tx, Ty) \leq ad(x, y), \quad \forall a \in (0,1)$$

$$Z_2 : d(Tx, Ty) \leq b[d(x, Tx) + d(y, Ty)] \qquad b \in (0, \frac{1}{2})$$

$$Z_3 : d(Tx, Ty) \leq c[d(x, Ty) + d(y, Tx)];\ c \in (0, \frac{1}{2}) \tag{3.4}$$

The equivalence of (3.4) is given as follows:

$$d(Tx, Ty) \leq h\max[d(x,y), d(x, Tx), d(y,Ty), d(x, Ty), d(y, Tx)] \tag{3.5}$$

where

$$h = max(a, b, c) \qquad and \qquad x, y \in X$$

The following Lemma is useful in the proof of our results.

Lemma 3.1

Let δ be real number such that $\delta \in [0,1)$ and $u_{n=0}^{\infty}$ is a sequence of non negative such that:

$$\lim_{n\to\infty} u_n = 0$$

Then for any sequence of positive numbers $x_{n=0}^{\infty}$ satisfying

$$x_{n+1} \leq \delta x_n + u_n \quad \forall \quad n \in N \tag{3.6}$$

we have

$$\lim_{n\to\infty} x_n = 0 \tag{3.7}$$

The Zamfirescu operator was used to proved the strong convergence of Picard iteration process is as stated below:

Theorem 3.2 *Let C be a nonempty subset of a normed space $(E,\|.\|)$. Let $C :\to C$ be Z-operator. if $F(T) \neq \phi$, $\sum_{n=1}^{\infty}\alpha_n = \infty$, $\|U_n\| = 0$. Then x_n converges strongly to a fixed point of T.*

Proof

By Lemma 3.1, T has a unique fixed point in C, say q, let $x, y \in C$; since T is a Z-operator, at least one of each condition Z_1 to Z_3 is satisfied. if Z_2 holds, then

$$d(Tx, Ty) \leq b[d(x, Tx) + d(y, Ty)] \tag{3.8}$$

is equivalent to

$$\| Tx - Ty \| \leq b(\| x - Tx \| + \| y - Ty \|)$$

$$\leq b[//x\text{-}Tx// + //y\text{-}x// + //x\text{-}Tx// + //Tx\text{-}Ty// \tag{3.9}$$

this implies

$$(1\text{-}b)//Tx\text{-}Ty// \leq b//x\text{-}y// + 2b//x\text{-}Tx// \tag{3.10}$$

therefore

$$//Tx\text{-}Ty// \leq \frac{b}{1-b}//x\text{-}y// + \frac{2b}{1-b}//x\text{-}Tx// \tag{3.11}$$

Similarly, if Z_3 holds, we obtain

$$//Tx\text{-}Ty// \leq \frac{c}{1-c}//x\text{-}y// + \frac{2c}{1-c}//x\text{-}Tx// \tag{3.12}$$

Let

$$\delta = max(a, \frac{b}{1-b}, \frac{c}{1-c}) \tag{3.13}$$

Then, we have $0 \leq \delta \leq 1$ and in view of (3.13) it results in inequalities (3.11) and (3.12), hence,

$$//Tx\text{-}Ty// \leq \delta //x\text{-}y// + 2\delta //x\text{-}Tx// \ \forall \ x,y \ C \tag{3.14}$$

Now, for $x = q$ and $y = x_n$ in (3.14), we obtain

$$//Tq\text{-}Tx_n // \leq \delta //q\text{-}x_n // \tag{3.15}$$

which implies

$$//x_{n+1} - q// \leq \delta //x_n - q// \tag{3.16}$$

By Lemma 3.1, we conclude that x_n converges strongly to q.

The adjusted S-iteration with errors:

$$x_n = (1-\alpha_n)Ty_{n-1} + \alpha_n Ty_{n-1} + e_n$$
$$y_{n-1} = (1-\beta_n)x_{n-1} + \beta Tx_{n-1} + f_n$$

We shall show the existence of the restructured S-iteration from the theorem below:

Theorem 3.3 *Let C be a nonempty subset of a normed space $(E,\|.\|)$. Let $T: C \to C$ be Z-operator. let x_n be defined with Modified S-iterative process. If $F(T) \neq \phi$, $\sum_{n=1}^{\infty} \infty_n = \infty$, $\|U_n\| = 0$. Then x_n converges to a fixed point of T.*

Proof

from (3.14), we have

$$\|Tx - Ty\| \leq \delta \|x - y\| + 2\delta \|x - Tx\| \qquad \forall x, y \in C$$

Also from (3.16), we have,

$$\|Tx_n - q\| \leq \delta \|x_n - q\|$$

Applying (3.16) to the above Modified S-iteration, we obtain

$$\begin{aligned}
&//x_n - q// \leq //(1-\alpha_n)Ty_{n-1} + \alpha_n Ty_{n-1} + e_n - q// \\
&= ||(1-\alpha_n)(Ty_{n-1} - q) + \alpha_n(Ty_{n-1} - q) + e_n|| \\
&\leq ||(1-\alpha_n)(Ty_{n-1} - q)|| + ||\alpha_n(Ty_{n-1} - q|| + ||e_n|| \\
&= (1-\alpha_n)||Ty_{n-1} - q|| + \alpha_n||Ty_{n-1} - q|| + ||e_n|| \\
&\leq (1-\alpha_n)\delta||y_{n-1} - q|| + \alpha_n \delta||y_{n-1} - q|| + ||e_n|| \\
&= [(1-\alpha_n)\delta + \alpha_n \delta]||y_{n-1} - q|| + ||e_n|| \quad (3.17)
\end{aligned}$$

Also by the same argument, we have

$$\begin{aligned}
&//y_{n-1} - q// \leq //(1-\beta_n)x_{n-1} + \beta_n Tx_{n-1} + f_n - q// \\
&= ||(1-\beta_n)x_{n-1} + \beta_n Tx_{n-1} - q + f_n - \beta_n q + \beta_n q|| \\
&= ||(1-\beta_n)(x_{n-1} - q) + \beta_n(Tx_{n-1} - q) + f_n|| \\
&\leq (1-\beta_n)||x_{n-1} - q|| + \beta_n \delta||x_{n-1} - q|| + ||f_n|| \\
&= [(1-\beta_n) + \beta_n \delta||x_{n-1} - q|| + ||f_n|| \qquad (3.18)
\end{aligned}$$

substituting (3.17) in Theorem (3.3)

$$\begin{aligned}
&//x_n - q// \leq [(1-\alpha_n)\delta + \alpha_n \delta][(1-\beta_n) + \beta_n \delta]//x_{n-1} - q// + //e_n// + //f_n// \\
&= (1-\alpha_n + \alpha_n)\delta(1-\beta_n + \beta_n \delta) \\
&= \delta(1-(1-\delta)\beta_n||x_{n-1} - q|| + ||e_n|| + ||f_n|| \qquad (3.19) \\
&(1-(1-\delta)\beta_n)//x_n - q// + //e_n// + //f_n// \quad (3.20)
\end{aligned}$$

By letting $\|g_n\| = \|e_n\| + \|f_n\|$, and by lemma 3.1, using the condition of the theorem, we have

$$\lim_{n\to\infty} \|x_n - q\| = 0$$

Hence

$$x_n \to q \in F(T)$$

Numerical Examples

We shall support our analytical results with the following Numerical examples using MATHLAB and compare the rate of convergence of Ishikawa, S-iteration and the Adapted S-iteration.

Example

Let the function $f:[0,4]\to[0,4]$ be defined by $f(x)=(2x+3)^{1/2}$ with fixed point $q=3.0000$. initial guess is $x_0=4$, $\alpha_n=\frac{1}{(n+2)}$ $\beta_n=\frac{1}{(n+1)}$

Numerical Results for Example 1

n	Ishikawa	Picard-mann	S-iteration	Adapted S-iteration
	4.000000000	4.000000000	4.000000000	4.000000000
	3.509525033	3.247216735	3.281733296	3.211950309
	3.328291361	3.067813070	3.087368905	3.054367130
	3.236413828	3.019521294	3.028018410	3.015059648
	3.181820429	3.005778131	3.009117873	3.004347135
	3.146067652	3.001740752	3.002989544	3.001287744
	3.121052680	3.000532251	3.000984449	3.000388340
	3.102689324	3.000164270	3.000325106	3.000118657
	3.088707277	3.0000511059	3.000107564	3.000036622
	3.077750686	3.000016002	3.000035372	3.000011393
	3.068963134	3.000005037	3.000011819	3.000003567
	3.061778846	3.000001593	3.000003922	3.000001123
	3.055810057	3.000000505	3.000001302	3.000000357
	3.050782729	3.0000000161	3.000000432	3.000000112
	3.046498066	3.000000051	3.000000143	3.000000035
	3.042808626	3.0000000016	3.000000048	3.000000014
	3.039602883	3.000000005	3.000000016	3.000000003
	3.036795039	3.000000001	3.000000005	3.000000001

	3.034180862	3.000000000	3.000000001	3.000000000
	3.032118983	3.000000000	3.000000000	3.000000000
	3.030155239	3.000000000	3.000000000	3.000000000
	3.028392438	3.000000000	3.000000000	3.000000000
	3.026802437	3.000000000	3.000000000	3.000000000
	3.025362007	3.000000000	3.000000000	3.000000000

n	Ishikawa	Picard-mann	S-iteration	Adapted S-iteration
	3.024518254	3.000000000	3.000000000	3.000000000
	3.022855690	3.000000000	3.000000000	3.000000000
	3.021759929	3.000000000	3.000000000	3.000000000
	3.019824750	3.000000000	3.000000000	3.000000000
	3.018966875	3.000000000	3.000000000	3.000000000
	3.018171931	3.000000000	3.000000000	3.000000000
	3.000867436	3.000000000	3.000000000	3.000000000

Conclusion

The convergence and convergence rate of a two-step iterative schemes with error using Zamfirescu operator in Banach spaces were proved. It was observed from the example considered, that the adapted S-iteration converges faster than the S and Ishikawa iterations. However, the scheme has the same convergence rate with Picard-Mann iteration. The adapted S-iteration is recommended for solving linear and quadratic problems involving a large number of variables where direct method would be prohibitively expensive even with the best available computing power. The result obtained from the numerical computation also confirm the validity of theoretical analysis.

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ARTICLES AND RESEARCH REPORTS ON EDUCATION

EFFECTS OF COMPUTER ASSISTED INSTRUCTION ON PUPILS' RETENTION IN WORD-FORMATION IN ENGLISH LANGUAGE IN NIGER STATE, NIGERIA

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Abstract
The study investigated effects of Computer Assisted Drill and Practice Instruction on Pupils Retention in English Language Word-formation in Niger State. The study adopted quasi–experimental design. Purposive sampling was used to select four schools from 2,603 schools in the seven educational zones in Niger State. 120 pupils were drawn as study sample from a population of 135,245 primary two pupils'. The study sample comprised of 62 males and 58 females. Control group was taught with lecture method while experimental group was taught with CAI Drill and Practice package. Two research questions and two hypotheses guided the study. English Language Achievement Test (ELAT) was used for data collection. The CAI package and ELAT were face validated by experts while the reliability was established using Kuder Richardson (KR 20) analysis and the reliability coefficient was found to be r = 0.74. Mean and standard deviation were used to analyze the research questions while Analysis of Covariance (ANCOVA) was used in the testing of the hypotheses. Findings show that CAI drill and practice package enhanced retention of English language word-formation. It is recommended that, primary school English language teachers should employ CAI packages to teach English language concepts.

Keywords: English Language, Word-formation, Computer Assisted Instruction, Drill and Practice, Achievement, Retention

Introduction

English language is the most widely used language in the world. English is very crucial as a medium for teaching and learning of all school subjects in the Nigeria educational system and is a pre-requisite for admission into nearly all programmes in the universities. The role English language plays in the world of communication and scientific advancement cannot be over emphasized. The government of Nigeria considers English language as a core subject in the school curriculum and a major medium of communication both within and outside the school system. The national policy on education, Federal Republic of Nigeria (FRN, 2004) demands ability to communicate effectively at the primary school level. The policy demands that the medium of instruction at primary school shall be the language of the environment for the first three years and from the fourth year English language shall be taught as a subject and used progressively as a medium of instruction.

The objective of this study was to find out the effects of computer assisted instruction CAI drill and practice package and lecture method on the mean retention scores of pupils' taught English Language Word-formation and the mean retention scores of male and female pupils' taught the same concept using alphabet A-J.

Retention is the ability to reproduce the learnt concept when the need arises (Damiral, 2004). Retention involves the ability to recall the content that has been given within a specific period of time. It is the ability to demonstrate what the learner has learnt and being able to demonstrate his/her cognitive skills in the subject (Wushishi, Danjuma, & Usman, 2013). However, pupils' ability to reproduce the learnt material could be through the use of

appropriate instructional methods like innovative teaching strategies in teaching. Learning could be made more effective, lasting and enjoyable and topics that are abstract to students could be made clearer, easier and meaningful for better achievement of concept learnt. Unfortunately, in our present day schools, most teachers' do not carry on diction in their teaching of English language and this affects students' knowledge of word-formation.

Word-formation is a serious problem among learners particularly in primary and secondary school level; this problem is largely due to the fact that dictation which was a very vital tool in word-formation or learning of words has been relegated to the background. Wise (1992) defined word-formation as an aspect of language learning which prepares an individual for language use during the primary school years. In other words, it is an act of acquiring new words to equip oneself for effective communication orally or in written form. Word-formation is very important in a child's learning because it increases pupils' acquisition of new words and also enhances flexibility in their expression and communication both within and outside the school. Pupils' ability to form words using various learning activities thereby expanding the breadth and depth of vocabulary knowledge e.g. the use of cross-word puzzles is very important in any learning process especially now that Nigerian school system is shifting from theory (lecture method) to practice.

Lecture method of teaching is the most widely used method employed by teachers in our institutions of learning. In this method of teaching, students are encouraged to sit quietly, listen and perhaps take down notes. Adeoye (2002) describes lecture method as one which involves the lecturer talking according to pre-planned, structured scheme while the students listen and make notes. Adeoye (2002) explained that it might not be easy to write off lecture method stressing that this method of teaching is not ideal for immature learners especially primary school pupils. It makes learners considerably passive and does not carter for individual differences in learners.

With the advent and introduction of ICT into the field of education it became necessary to shift from lecture method of teaching to use of ICT interactive learning devices such as computer which makes leaner to be actively involved in the learning process unlike lecture method of teaching which makes learners passive and had contributed to learners 'poor achievement in English language. Computer Assisted Instruction (CAI) is a relatively new educational innovation in primary school classrooms in Nigeria and Niger State in particular. Nigeria as a developing nation requires solid foundation in computer assisted instruction at the primary school level if it must compete favorably with other nations of the world (Aniah, 2015).

Nwoji (2002) stated that students' retention could be attained through the use of CAI packages as medium of instruction in the teaching and learning of word-formation because it makes learning more meaningful and enjoyable. Kara (2008) investigated the effect of CAI package on physics students' retention in the area of (force and pressure) the experimental group that was taught with CAI had higher retention level than control group that was taught with conventional lecture method. Based on the above fact, it has become imperative for Nigeria and indeed Niger State to integrate and use CAI in teaching English language word-formation in primary schools to enhance students' retention.

Computer Aided Instruction (CAI) package according to Ash (2005) is an interactive instructional technique whereby a computer is used to present the instructional material and monitor the learning that takes place. Umaru (2003) defined Computer Assisted Instructional package as a program of instruction presented as computer software for instructional purposes. In line with this, Basturk (2005) referred to CAI as the use of the computer as a

tool to facilitate and improve instruction. The following are types of Computer Assisted instruction, drill and practice, tutorial, games, simulation, discovering and problem solving. In this study, the CAI that was used to carry out the research is drill and practice.

Drilling mean listening to a model provided by a teacher or a tape or another student and repeating what is heard. Drills are a form of very controlled practice. In drill exercises, there is one correct answer and the main focus is on 'getting it right' i.e on accuracy. Drills are usually conducted chorally (i.e. the whole class repeats) then individually. There is also the possibility of groups or pairs of students doing language drills together. Its' main purpose is to help learners master materials at their own pace. Drills are used as reinforcement tool and are mainly used for beginners or for students who are experiencing learning problems. Onyejekwe (2006) described drill as the condition in which a learner is encouraged to practice a skill over and over again until he masters such skill. Drill and practice software packages provide feedback to students, explain how to get correct answer and contain a management system to keep track of student progress. Onyejekwe (2006) stated that drill and practice is probably the most common and best known educational application of the computer. Such repetitive actions are employed in the learning of mathematics, reading, word-formation, and other basic skill areas. Drill and practice exercises with the appropriate software can enhance the daily classroom experience (Julie, 2015).

The procedure for using CAI drill and practice package instructional delivery in teaching letters A-J, demand that only one letter at a time is treated. For instance, if a child gets an option or answer correct after teaching letter "A" the teacher proceed to the next letter but if the child gets the option wrong, revisit the same letter until the child gets it right. This procedure is applicable to letters A-J used in this study. The study also determines the influence of CAI drill and practice on gender retention using letters A-J.

The concept of gender is used to describe those characteristics of men and women that are societal determined, in contrast to those which are scientifically determined which affect the use of computer in teaching and learning of science concepts (Nworgu, 2005). Gender difference is one of the factors affecting learning and many researchers have focused their attention on studies relating to its effect on pupils' academic achievement. Some findings indicated that significant differences existed between the achievement of male and female students. Abdullah, Jebreen, Aieman and Sadeq (2009) in their use of CAI for teaching English grammar revealed that there was significant difference in achievement in favour of male students. Noabi (2003) study shows that there was no significant difference in the mean achievement of male and female students while other findings showed that gender factor had no influence on students' achievement (Yusuf, 2004). The author noted that gender has no impact on students' academic achievement. This evidence in academic achievement due to gender had resulted in the need to verify the influence of computer assisted instructional packages on pupils' English language word-formation. This suggests why gender in academic had remained an issue of discussion and inconclusive among scholars. However, from the studies made so far on the use of CAI packages, no research has been carried out on the effects of CAI packages on retention and gender on pupils' English language word-formation in Niger State.

It is against this background that the study investigated the effects of computer assisted drill and practice instructional package on pupils' retention in English language word-formation in Niger State.

Statement of the Problem

The retention of pupils' in English language has not been encouraging despite its' importance to national development. The researcher observed that pupils have serious problems with English language word-formation because of mother tongue interference; pupils' use of cell phones or handsets for text messages which has negative impact on their learning because of short cut in word-formation. Pupils' poor retention has been attributed to poor teaching methods employed by teachers' and the non-utilization of instructional materials, poor knowledge of the subject and expression by teachers and inadequate relevant English language textbooks that contain activities on word-formation. Furthermore, some pupils cannot pronounce English language words correctly. This has contributed to pupils' poor formation in English language words at the primary and secondary school levels. This poor retention calls for urgent action to reverse the situation from primary school which is the foundation for other levels of education. Thus, to enhance the teaching of word-formation, the pupils must first know their alphabets and should be able to listen to people very well and also be able to inculcate in them the skills involved in listening. It was against this background that the researcher used CAI drill and practice package as media of instruction to find out its' effects on pupils' retention in word-formation in Niger State.

Research Questions

(i) What are the mean retention scores of pupils taught English language word-formation with CAI drill and practice package and lecture method using alphabet A-J?

(ii) What are the mean retention scores of male and female pupils taught English language word-formation with CAI drill and practice package and lecture method using alphabets A-J?

Hypotheses

The following null hypotheses were formulated and tested at 0.05 Alpha Level of significance:

HO_1: There is no significant difference in the mean retention scores of pupils taught English language word-formation with CAI drill and practice package and lecture method using alphabet A-J.

HO_2: There is no significant difference in the mean retention scores of male and female pupils taught English language word-formations with CAI drill and practice and lecture method using alphabet A-J.

Methodology

This study adopted the quasi- experimental design. Specifically, the quasi-experimental design is the non-equivalent control group design. This is because intact classes (i.e pre-existing groups) were used, since randomization was not possible.

The design layout:

Group	Pretest	Treatment	Posttest	Retention
Experimental	O_1	X	O_2	O_3
Control	O_1		O_2	O_3

Where:

O_1 refers to pre-test performance,

O_2 refers to posttest performance,

O_3 refers to retention performance and

X refers to treatment for Experimental - CAI Condition

The study was carried out in Niger State due to the fact that the state is one of the states the primary school pupils have been identified with the problem of poor achievement in

English language. Niger State comprises of 25 Local Government Areas grouped into seven educational zones. These zones include Bida, Kutigi, Minna, Suleja, Kontagora, Rijau and New-Bussa. The choice of the schools in the seven educational zones is for equal representation and generalization of outcome of the study.

The population of the study comprises all the primary two pupils in public schools in the seven educational zones in Niger State. The number of public primary schools in the seven education zones is 2,603. The population of primary 2 pupils in these schools is 135,245. (Niger State Universal Basic Education Board, 2014).

The researcher adopted multistage sampling techniques. 120 pupils were drawn as sample from the seven Educational Zones made up of 25 Local Government Areas in Niger state. The study sample consists of 62 males and 58 females. Purposive sampling technique was used to draw four government owned public primary schools from three Educational Zones in Niger State comprising of (Zone A, B and C).

The instrument that was used for collecting the data of this study is the researcher made English language Achievement Test on Word-formation (ELAT). The English Language Achievement Test covered word-formation using ten English language alphabets A-J. The chosen concepts were selected from primary two pupils English language syllabus and it corresponds to what the pupils should be taught in their school at the time of study. Each item of the instrument was based on word-formation from English language alphabets or letters.

The English language test items on (word-formation) were subjected to face and content validity by four experts, two from school of General Studies, Federal University of Technology, Minna and the other two from the Department of English language, Niger State College of Education, Minna. The experts critically examined all the words-formed using alphabets A-J. They were to ascertain the relevance of the words formed to the content and extent to which the content covered the topics they are meant to cover. The test items and contents of the package were later modified on the basis of suggestions and recommendation of experts. Furthermore, the content of validation was carried out using table of specification.

The developed instructional package was also validated by four experts, two of them were from Science Education Department, Federal University of Technology Minna, Niger State and two from Department of Arts Education, University of Nigeria, Nsukka (UNN). They were requested to validate the package in terms of the appropriateness of the package for the chosen topics, clarity and simplicity as well as its suitability for the level of primary two pupils and possible errors in the structuring of the package. The experts comment and suggestions were used to correct some mistakes while their suggestions and recommendations were used to improve on the package.

The test on English language word-formation was administered to 30 primary two pupils' who constitute part of the population but were not used in the main study. The trial testing helped the researcher to determine the appropriate timing of the test as well as identify any problem which may affect the administration of the instrument during the study. The scores of the 30 pupils' were subjected to estimate of temporal stability using test-retest method with two weeks interval. The two set of scores obtained were subjected to Kuder Richardson (KR 20) correlation analysis. A correlation coefficient of $r = 0.74$ was obtained from the analysis. This value therefore revealed that the instrument is reliable for English Language Achievement Test on retention (ELAT).

The instrument that was used for data collection in this study was English language Achievement Test on retention (ELAT). Prior to the commencement of the experiment (ELAT) on word-formation was administered on all the primary 2 pupils as pretest in the participating schools. Similarly at the expiration of the experimental period (four weeks) the post-test on English language Achievement Test (ELAT) was administered on the experimental and control groups with the aid of English language research assistants. The scores obtained from the experimental and control groups were used to determine the academic retention of both groups. The scores of the experimental and control group on the posttest were computed, recorded and use for data analyses.

The instrument (ELAT) was administered to the experimental and control group as pre-test. To reduce the retest effects, the questions were reframed and administered as post-test. On the scoring of the test items, marks were awarded for correct responses based on marks assigned to each section and zero for incorrect answer.

The research questions were answered using mean and standard deviation. The hypotheses for the study were analyzed using Analysis of Covariance (ANCOVA) using Statistical Package for Social Sciences (SPSS).The significance of the various statistical analyses were ascertained at 0.05 alpha level

Results

The result was presented in line with research questions and hypotheses that guided the study.

Research Question 1: What are the Mean Retention scores of Pupils taught English Language Word Formation with CAI Drill and Practice and Lecture Method using alphabet A-J?

Table 1: Mean Retention Scores of Pupils taught English Language Word Formation with CAI Drill and Practice and Lecture Method.

Group	N	Pretest		Posttest		Mean Gain
		Mean	SD	Mean	SD	
Experimental	60	19.47	5.23	35.00	2.51	15.53
Control	60	16.27	7.29	25.80	8.94	9.53
Total	120	17.87	6.26	30.40	5.73	12.53

Table 1 shows the word formation posttest mean scores of Experimental group (CAI Drill and Practice) and Control (Lecture Method) to be 35.00 and 25.80 respectively. This shows that CAI Drill and Practice enhanced pupils' achievement in word formation more than lecture method.

HO_1: There is no significant difference in the Mean Retention Scores of Pupils taught English Language Word-Formation using alphabet A-J with CAI drill and practice package and those taught using lecture method.

Table 1: Summary of ANCOVA for Retention Scores of Pupils taught English Language Word-Formation using CAI Drill and Practice package and Lecture Method

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Decision
Corrected Model	1482.659	2	741.329	30.174	.000	
Intercept	2885.586	1	2885.586	117.450	.000	
Posttest	378.526	1	378.526	15.407	.000	
Method	253.331	1	253.331	10.311	.002	S
Error	2874.541	117	24.569			
Total	124944.000	120				
Corrected Total	4357.200	119				

Significant ($p < 0.05$)

Table 1 shows that there is significant difference in the mean retention scores of pupils taught English Language word formation with CAI Drill and Practice and lecture method since the $F(1,117) = 10.311$, $p = .002$ which is less than 0.05. Hence the null hypothesis was rejected.

Research Question 2: What are the Mean Retention Scores of Male and Female Pupils taught English Language Word-Formation with CAI Drill and Practice?

Table 2: Mean Retention Scores of Male and Female Pupils taught English Language Word Formation with CAI Drill and Practice.

		Pretest		Posttest		
Experimental Gender	N	Mean	SD	Mean	SD	Mean Gain
Male	28	19.14	6.00	34.86	2.85	15.72
Female	32	19.75	4.54	35.13	2.64	15.38
Total	60	19.47	5.23	35.00	2.72	15.55

Table 2 shows that the mean retention scores of male and female pupils taught Word-Formation with CAI drill and practice are 34.86 and 35.13 respectively with SDs of 2.85 and 2.64 respectively. The mean achievement score of female pupils is slightly higher than that of their male counterparts. The mean gain of male pupils is 15.72 while that of their female counterparts is 15.38. This suggests that both male and female pupils achieved almost equally when taught English language Word Formation using CAI drill and practice.

HO_2: There is no significant difference in the Mean Retention Scores of Male and Female Pupils taught English Language Word Formation using alphabet A-J with CAI drill and practice package.

Table 2: Summary of ANCOVA for Retention Scores of Male and Female Pupils taught English Language Word Formation using alphabet A-J with CAI Drill and Practice Package

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Decision
Corrected Model	23.777	2	11.888	.892	.416	
Intercept	276.190	1	276.190	20.715	.000	
Posttest	5.472	1	5.472	.410	.524	
Gender	20.293	1	20.293	1.522	.222	NS
Error	759.956	57	13.333			
Total	73168.00	60				
Corrected Total	783.733	59				

Not Significant ($p > 0.05$)

Table 2 shows that there is no significant difference in the mean retention scores of male and female pupils taught English language word formation with CAI drill and practice since the $F(1,57) = 1.522$, 0.222 which is greater than 0.05. This suggests therefore that CAI drill and practice is not gender sensitive in enhancing retention in English language word formation. Thus the null hypothesis 2 was accepted.

Discussion

The findings of this study showed that CAI Drill and practice package enhanced pupils' retention in English Language Word-formation more than lecture method. This result agrees with Nwoji (2002) who stated that students' retention could be attained through the use of CAI packages as medium of instruction in the teaching and learning of word-formation because it makes learning more meaningful and enjoyable. Kara (2008) work is in agreement with the findings of Nwoji (2002). Kara (2008) investigated the effect of CAI package on physics students' retention in the area of (force and pressure) the experimental group that was taught with CAI had higher retention level than control group that was taught with conventional lecture method. There was no significant difference in the mean retention scores of male and female pupils' taught English language word-formation using CAI drill and practice package. Noabi (2003) study on students' using computer assisted instruction package in tertiary institutions shows that there was no significant difference in the mean retention of male and female students. This suggests why gender in academic had remained an issue of discussion and inconclusive among scholars.

Conclusion

The following conclusions were made based on the findings of this study. The result of this study provides empirical evidence that the use of CAI drill and practice package enhanced pupils' retention in English language word-formation more than the use of lecture method. Pupils' taught English language word-formation with the use of CAI package (experimental group) retained better than the pupils' (control group) taught the same English Language word-formation using lecture method. There was no significant difference in gender retention of pupils taught English Language word-formation with CAI drill and practice package. This implies that gender has no significant effect on retention of pupils' in English language word-formation using CAI drill and practice package. Therefore, the use of CAI drill and practice package enhanced the teaching and learning of English language word-formation.

Recommendations

The following recommendations were made based on the findings of this study:

(i) Since the use of CAI drill and practice enhanced retention of pupils' in English language word-formation, the English language primary school teachers should use it as one of the techniques to be employed in classroom teaching and learning.

(ii) Curriculum developers should embrace and include computer assisted instructional strategies that will bring about improvement in learning, acquisition of critical thinking, problem solving and performance skills in students into the curriculum.

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MANIFESTATIONS OF DEPRESSION AMONG UNDERGRADUATES OF UNIVERSITIES IN KWARA STATE, NIGERIA: IMPLICATIONS FOR COUNSELLING

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Abstract
Depression is a common mental disorder that presents with depressed mood, loss of interest or pleasure, decreased energy, feelings of guilt or low self-worth, disturbed sleep or appetite and poor concentration. This study was therefore carried out to investigate the manifestations of depression among undergraduates of universities in Kwara State. It also examined the influence of variables of religious affiliation and level of study on undergraduates' responses. Descriptive survey design was adopted for this study and multi-stage sampling procedure which comprises purposive, proportional, stratified and simple random sampling techniques were adopted to draw a total sample of 600 undergraduates from two universities in Kwara State. "Manifestations of Depression Questionnaire (MDQ)" was used to collect relevant data. The instrument was subjected to test re-test reliability co-efficient which yielded the score of 0.78 and the hypotheses were analysed using t-test and Analysis of Variance (ANOVA) at 0.05 significance level. Frequency counts and percentages were used to present the demographic data. The findings of the study identified poor school academic performance, avoidance of responsibility and difficulty in day to day tasks, health problems and loss of self-confidence as major manifestations of depression among undergraduates of universities in Kwara State, Nigeria. The hypotheses tested revealed no significant difference in the manifestations of depression among undergraduates of Universities in Kwara State based on religious affiliation and level of study. In line with the findings of this study, it was recommended among others that members in peer groups should be encouraged to assist one another and encourage prompt report of depression.

Keywords: Depression, Manifestation, Undergraduates, Kwara State

Introduction

Depression is a persistent illness, but one that can be treated (Philip, 2004). The term depression was originally derived from a Latin verb "*deprimere*" meaning- to press down. To press down also means to subjugate or bring down in spirits. This term was used in 1665 by an English author, Richard Backer in his work entitled "chronicle" to refer to having a great distortion in spirit. It was also used by another English author Samuel Johnson in similar manner in 1753. The term comes into use in physiology, economics and geography where they mean different things. An early usage referred to depression as psychiatric disorder was by famous French psychiatrist, Louis Delasiauve, in 1856. He viewed it as a physiological and metaphorical lowering of emotional function of human beings (The New Encyclopedia Britannica, 2002).

Depression is defined by Marcus, Yasamu, Ommeren, Chisholm and Sexana (2012) as a common mental disorder that presents with depressed mood, loss of interest or pleasure, decreased energy, feelings of guilt or low self-worth, disturbed sleep or appetite and poor concentration. Depression described a range of moods, from low spirits that we all experience to a severe problem that interferes with everyday life (World Mental Health Federation, 2012).

Nevertheless, depression is said to differ from a mere simple grief, bereavement or mourning mood which are appropriate emotional responses toward unwanted

circumstances. There is a clear ground for expression of unhappiness in human life. However, depression is present when the depressed mood expression is disproportionately long and severe via-a-vis the precipitating event (The New Encyclopedia Britannica, 2002). "Certainly an acute episode of depression will last only a week, a month, or even a year would change everything. It would still be a ghastly ordeal, but the worst thing about it, is the incessant yearning for death, the compulsion toward suicide would drop away but not a limited depression because a depression with hope is a contradiction .The experience of convulsive pain, along with the conviction that it will never end except in death that is the definition of a severe depression" (Grohol, 2008). Depression in this study refers to psychological disorder suffered by students of tertiary institution which usually manifested through avoidance of responsibility, poor school performance, difficulty in day to day task among others.

Manifestations of Depression

Depression, if left untreated for a considerable period of time, can have serious and sometimes long lasting damaging effects that can affect almost all aspects of human's life. The following are some of the common manifestations of depression (Jed Foundation, 2014).

(i) **Suicide**: Having thoughts of death are symptoms of depression. However, if depression is left untreated its resultant effect could be suicide.

(ii) **Self Injury:** In coping with depression, some people inflict pain and injury upon themselves by cutting or burning parts of their body. While some people do not really intend to harm themselves but the reason behind it is depressed mood. With these behaviours, serious and life-threatening injuries and accidental death may occur.

(iii) **Reckless Behaviour:** When people are feeling hopeless, angry or really bad about themselves, they are less likely to take care of themselves and think about the consequences of their actions. Depressed individuals may put themselves in risky situations with obvious devastating effects. For instance, driving drunk, unprotected sex and so on.

(iv) **Poor School Performance:** An untreated depression can also lead to difficulty in going to class and complete assignments. This is because depression diminishes one's ability to concentrate, remember things and make wiser decisions.

(v) **Relationship Problems:** Depression leaves people drained emotionally, mentally and physically, so it becomes hard to be outgoing with friends and family members.

(vi) **Health Concerns**: Depression can become an unhealthy cycle. People with depression need to take good care of themselves to feel better but because of the symptoms, they do not want to sleep or either sleep too much, they do not want to eat and they do not have interest in exercise. As a result of these, their depression worsens and their health also suffers. This can leave depressed person vulnerable to other illnesses such as the flu which worsens his or her own health condition.

On a final note, depression can have a devastating impact on the sufferer's ability to learn and function within the learning environment. Those with depression may experience a significant drop in grades due to decreased work readiness and work performance, lack of participation and increased tiredness to and absences from school. Depression has significant impact on how the brain functions. It makes sufferers become unmotivated and even disorganized and may have increased difficulty with short term memory. Depression and school failure can be a self-perpetuating cycle while depression contributes to school failure, school failure can also exacerbate depression in students (Students First Project, 2013).

Problem

Depression accounted for loss in any known organization than any other form of mental disorder. In a research, Ndu, Arinze-Onyia, Aguwa and Obi (2011) asserted that depression is associated with increase in risky behaviours, non-compliance to treatment, higher risk of co-morbid disorders and shortened survival. Depression can also interfere with students' study, eating pattern, sleeping patterns and can cause mental dysfunction among others in the affected persons. Besides, human body has been described as an amazing study in awesomeness (Solaade, 2013). Human body is a living machine (Jafar, 2009). Research contends that human body "talks" by cracking, popping, growling, ringing and whistling, only that they are being ignored by human beings, but assuming these noises of the body are being listened to and addressed appropriately before the worse time comes (that is, final breakdown), this could have saved human beings the hassles of spending money in hospitals on many of psychological diseases like depression.

Worldwide, there are certain risk factors that make some people more likely to get depressed than others (World Mental Health Federation, 2012). Moreover, many studies have been carried out on depressive disorders among many perimeters, culture and influences across the globe. For instance, Adeoye and Yusuf (2011) appraised the prevalence and causes of depression among the civil servants in Osun State, Nigeria. They found that majority of civil servants interviewed were suffering from depression meaning that it is prevalent among the civil servants. Their study also revealed that women are at risk than their men counterparts and that job demands and poor remunerations are the major factors that lead to depression among civil servants.

To the best of the researchers' knowledge, there is a gap yet to be filled as none of the aforementioned studies covered the manifestations of depression among undergraduates of universities in Kwara State. This study filled this gap by investigating the manifestations of depression as perceived by undergraduates of universities in Kwara State, Nigeria.

Research Questions

(i) What is the level of manifestations of depression as perceived by undergraduates of Universities in Kwara State?
(ii) Is there any difference in the level of manifestations of depression as perceived by undergraduates of Universities in Kwara State based on religious affiliation?
(iii) Is there any difference in the level of manifestations of depression as perceived by undergraduates of Universities in Kwara State based on level of study?

Research Hypotheses

Ho_1: There is no significant difference in the level of manifestations of depression as perceived by undergraduates of Universities in Kwara State based on religious affiliation.
Ho_2: There is no significant difference in the level of manifestations of depression as perceived by undergraduates of Universities in Kwara State based on level of study.

Research Design

The researchers adopted descriptive survey design. Descriptive survey provides an opportunity for the researcher to present information about the characteristics within a particular field of study with the purpose of providing a picture of situations, as they naturally exist (Burns & Grove, 1995).

Population, Sample and Sampling Techniques

The population of this study comprised the entire undergraduates of Universities in Kwara State. The target population for the study consisted of all undergraduates of two Universities in Kwara State. These two universities are University of Ilorin and Kwara State University. However, the study's target population is 38, 828 as at the time of this study. Out of this figure, University of Ilorin has a lion share of 34,000 undergraduates population (The Sun News Paper report of March 18, 2014), and Kwara State University (KWASU) has 4,828 (Olayinka & Alaya, June 5, 2013). The technique that was used in selecting sample for this study is a multi-stage sampling technique. At stage 1, purposive sampling technique was used to select purposively two Universities among all Universities that are in Kwara State.

At stage 2, proportional sampling method was used to select five hundred and twenty-six (526) undergraduates from University of Ilorin and seventy-four (74) from Kwara State University, all together making a total of six hundred (600) participants for the study. The above figures were based on the following percentages and represent the proportional contribution of each of the two universities used by the researchers in this study using simple calculation thus; University of Ilorin (UNILORIN) = (34,000/38,828* 100) = 87.6% of the target population and Kwara State University (KWASU) = (4,828/38,828* 100) = 12.4% of the study's target population. It is on this calculation that the sample size of each of the two universities studied was proportionally worked out from the 600 respondents considered for study. Thus; UNILORIN; (600*87.6/100) = 526 representatives and KWASU; (600*12.4/100) = 74 representatives. However, the addition of representatives of the two Universities give thus; (526 + 74) = 600.

At stage 3, stratified sampling method was used to categorize the respondents into various groups of interest of the researchers such as religious affiliation and level of study. Stratified sampling is done to ensure that certain sub-groups (for instance African Traditional Religion, Christianity & Islam) in the population are represented adequately in the sample of study (Ibrahim, Landu, & Opadokun, 2004).Thus, the stratified sampling will be used to select the sample of the study in respect to the variables under study. At the stage 4, simple random technique was used to select sample at random from all the identified sub-groups of the study.

For the purpose of this study, questionnaire was used as a measuring device which is personally designed by the researchers after a well guided and thorough review of literature and the questionnaire was tagged "Manifestations of Depression Questionnaires (MDQ). The questionnaire therefore consists of 2 sections; A and B. Section A: focuses on the demographic data of the respondents which include information on religious affiliation and level of study of respondents. Section B consists of twenty (20) items seeking information from the respondents on the manifestations of depression. The respondents responded to the items using: Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD).

In order to ascertain the validity of the instrument, the draft of the questionnaire was given to seven experts in the Department of Counsellor Education, University of Ilorin for vetting and advice. Sequel to their suggestions, necessary amendments were made.

The reliability of the instrument was ascertained using the test re-test reliability method. The questionnaire was administered on 30 undergraduates from University of Ilorin, who did not form part of the study but possess the similar characteristics or attributes of the population. After a period of four weeks, the same instrument or questionnaire was re-administered on the same group of people. The two sets of scores obtained differently on the two occasions were correlated using Pearson Product Moment Correlation Co-efficient (r) statistical

method. The value obtained was 0.78 at 0.05 alpha level of significance. Thus, the instrument is reliable for the study.

The data obtained were analysed using frequency count, percentages, mean and standard deviation as well as rank order for the descriptive data while t-test and Analysis Of Variance (ANOVA) statistical analysis were used to test the null hypotheses generated.

Results

Table 1: Distribution of Respondents Based on Religious affiliation and Level of study

No.	Variables		Frequency	Percentage (%)
1	**Religious Affiliation**	Christianity	217	36.2
		Islam	302	50.3
		Others	81	13.5
		Total	**600**	**100.0**
2	**Level of Study**	100 Level	115	19.2
		200 Level	236	39.3
		300 Level	147	24.5
		400 Level	68	11.3
		500 Level	18	3.0
		600 Level	16	2.7
		Total	**600**	**100.0**

Table 1 presents the distribution of respondents based on religious affiliation and level of study. The total number of respondents who participated in this study is 600 out of which, 217 (36.2%) of the respondents were Christians, 302 (50.3%) were Muslims while 81 (13.0%) were from other religious sects. In regards to level of study, 115 (19.2%) were in 100 level, 236(39.3%) were from 200 level, 147 (24.5%) were in 300 level, 68 (11.3%) were in 400 level, 18 (3.0%) were in 500 level while 16 representing (2.7%) were in 600 level.

Research Question One: What are the manifestations of depression as perceived by undergraduates of Universities in Kwara State?

Table 2: Mean and rank order on manifestations of depression as perceived by undergraduates of universities in Kwara State, Nigeria

Item No.	I experienced the following on my depression:	Mean	Rank
4	Poor school performance	3.15	1st
1	Avoidance of responsibility	3.14	2nd
12	Difficulty in day to day task	3.12	3rd
6	Health problems	3.11	4th
20	Loss of self-confidence	3.10	5th
19	Difficulty in thinking	3.10	5th
7	Loss of friends	3.10	5th
9	Eating problem (over eating or under eating)	3.09	8th
15	Hatred for academic pursuits	3.08	9th
13	Sleep disorder or sleep difficulty (insomnia)	3.07	10th
5	Difficulty in relating with others	3.06	11th
10	Truancy	3.05	12th
16	Loss of weight	3.04	13th
11	Telling lies	3.03	14th

18	High cost of hospital visitation	3.03	14th
14	Avoidance of social activities	3.01	16th
8	Difficulty in making decision	3.01	16th
17	Self-injury	2.98	18th
3	Reckless behaviour (e.g. drug/alcohol abuse)	2.93	19th
2	Suicidal behaviour	2.87	20th

Table 2 presents the mean and rank order of the manifestation of depression among undergraduates of Universities in Kwara State, Nigeria. The table shows that item 4 (with score mean of 3.15) which stated that "I experienced poor school performance while feeling depressed" was ranked first. Item 1 (with mean score of 3.14) which stated that "I experienced avoidance of responsibility while feeling depressed" was ranked second while item 12 (with mean score of 3.12) which stated that "I experienced difficulty in day to day tasks" was ranked third respectively. On the other hand, items 17, 3 and 2 were ranked 18th (with mean score of 2.98), 19th (with mean score of 2.93) and 20th (with mean score of 2.87) respectively. The items indicated self-injury, reckless behaviour and suicidal behaviour as the least manifestation of depression. It can be concluded that the leading manifestations of depression as perceived by undergraduates of Universities in Kwrara States are poor school academic performance, avoidance of responsibility, difficulty in day to day tasks, health problems, loss of self-confidence etc.

Hypothesis One

There is no significant difference in the manifestations of depression as perceived by undergraduates of Universities in Kwara State based on religious affiliation.

Table 3: ANOVA showing the manifestation of depression as perceived by undergraduates of universities in Kwara State based on religious affiliation.

Gender	**df**	**SS**	**Means Square**	**p-value**
Between Group	2	221.602	110.801	
Within Group	597	58322.898	97.693	0.39
Total	599	58544.500		

Table 3 shows that the p-value of 0.39 is greater than 0.05 level of significance. This means that there is no significant difference in the manifestations of depression as perceived by undergraduates of Universities in Kwara State based on religious affiliation. Thus, the hypothesis is not rejected.

Hypothesis Two

There is no significant difference in the manifestations of depression as perceived by undergraduates of Universities in Kwara State based on level of study.

Table 4: ANOVA showing the manifestation of depression as perceived by undergraduates of universities in Kwara State based on level of study

Gender	**df**	**SS**	**Means Square**	**p-value**
Between Group	5	1011.411	202.282	
Within Group	597	57533.089	96.857	
Total	599	58544.500		0.22

Table 4 shows p-value of 0.22 which is greater than alpha level of 0.05. This means that there is no significant difference in the manifestations of depression as perceived by undergraduates of Universities in Kwara State based on level of study. Thus, the hypothesis is not rejected.

Discussion

The findings identified poor school academic performance, avoidance of responsibility, difficulty in day to day tasks, health problems and loss of self-confidence as major manifestations of depression among undergraduates of Universities in Kwara State, Nigeria. The finding is in line with the notion of Glied and Pine (2002) that depressed adolescents are at much higher risk of poor performance at school. This is because the victim of depression might have loss interest in any activities he/she engages and feels nothing worth striving for in life. According to Beck, Rush, Shaw and Emery (1979), the essential feature of the content of depressive disorders is the concept of the cognitive triad, or negative views of self, world, and future. The result of the study indicated that students in universities in Kwara state have perceived moderate level of depression. The respondents scored between 3.00 and 3.40 in 17 out of 20 items while 3 out of 20 items have low level of depression.

Hypothesis one revealed no significant difference in the level of manifestations of depression among undergraduates of Universities in Kwara State based on religious affiliations. Religion does not differentiate respondent's manifestations of depression. This may be due to the fact that all forms of religion accord people opportunities for social support, which has been found to protect people against depressive symptoms (George, Larson, Koenig & McCullough, 2000). The finding is in consistence with the study of Koenig, George and Peterson (1998) whose finding indicated that certain aspects of religiousness (e.g., public religious involvement, intrinsic religious motivation) may be inversely related to depressive symptoms (with greater religious involvement associated with fewer symptoms of depression).

The result of hypothesis two revealed no significant difference in the manifestations of depression among undergraduates of universities in Kwara State based on level of study. The finding corroborates the study of Joel, Cassie and Cassandra (1997) who found a positive relationship between level of study and depression but without differentiation among levels.

Conclusion

The findings identified poor school performance, avoidance of responsibility, and difficulty in day to day tasks, health problems and loss of self-confidence as the major manifestations of depression among undergraduates of Universities in Kwara State, Nigeria. The results revealed moderate level of manifestations of depression in 17 out of 20 items. This shows the need for counselling to prevent high level of manifestation of depression among students of universities in Kwara state. The result of the hypotheses revealed no significant difference in the manifestations of depression among undergraduates of Universities in Kwara State based on religious affiliation and level of study.

Counselling Implications

Counsellor in the academic environment should be aware of students' behaviours, health status and their interpersonal relationship with others in order to identify depressed students and to provide adequate counselling intervention that could help such students overcome the impending problem. Counsellors and the Counselling Centres in various higher institutions of learning in Kwara state should intensify efforts in palliative measures to cushing the effect of economic crack down on students such measure include: scholarship to indigent students' study work scheme etc. The centre should continue to sensitize students

to the function of counselling centre so that they can patronise them for their concern and receive adequate counselling to avoid depression.

Recommendations

In line with the findings of the study, the following recommendations were made:
Counsellors should be employed in all Nigerian schools (from primary to tertiary level) so that students can share their concerns with them. The counsellors would help them to be aware of their concerns and provide lasting solution to the identified problems such as replacing negative thoughts with positive ones, learning of appropriate coping skills and so on. Students in tertiary institutions need to attend valuable programmes organised and designed by the Counselling Centre to help them adjust to environment and taken necessary steps to prevent problem that could cause depression and other challenges. The peer groups in the school should assist one another in identifying depressed students and refer such to the school counselling unit for appropriate counselling intervention.

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EFFECT OF TECHNOLOGY QUALITY ON PERCIEVED USEFULNESSS AND EASE OF USE OF JAIZ ISLAMIC BANK IN ENHANCING E-BANKING EFFICIENCY IN NIGERIAN DWINDLING ECONOMY

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Abstract
This study was conducted to assess the effect of technology quality on perceived usefulness and ease of use of Jaiz Islamic Bank (JIB) in enhancing e-banking efficiency in the Nigerian dwindling economy using technology acceptance Model (TAM). Questionnaires were used as means of data collection. The survey data was analysed using both descriptive statistics and Structural Equation Model (SEM). Three hypotheses were tested in the study. The study revealed that technology quality has no influence on the customers' perceived usefulness of the JIB e-banking. It also indicates that the JIB e-banking technology quality provides ease of use benefits to the customers. Finally, the study revealed that there is a direct positive significance relationship between perceived ease of use and perceived usefulness. Both the measurement and structural models show that the models fits the data collected without having to revise it, an indication of a good models. It is recommended that JIB improvement on quality of its technology is crucial especially the way their customers perceived the usefulness of its e-banking. Similarly, JIB should put more efforts on improving its technology quality so that people will develop positive perception on how easy it is to use their e-banking.

Keywords: Technology Quality, Perceived Usefulness, Ease of Use, Jaiz Islamic Bank (JIB), Enhancing E-Banking Efficiency, Nigerian Dwindling Economy

Introduction

E-banking refers to the usage of technology for delivery of information to and from the bank on any financial transactions. This type of services include the system that allows banking institutions and their clients to gain access to their accounts, and obtain the needed information immediately as well as make any financial transactions via a private or public network (Prakash & Malik, 2008). The banking industry plays a very crucial role in the economic development of any nation because it lubricates the engine of economic activities. Nonetheless, especially in developing countries like Nigeria, the banking industry to date has conducted its business based on traditional banking system.

Recently an important evolving phenomenon changing the landscape of banking and finance in Nigeria today is the advent of Islamic banking and finance and e-banking alternative. With the introduction of e-banking option in some countries especially developing one like Nigeria there are some issue with the technology quality (Agwu, 2012). It is in view of that information technology including e-banking studies has been conducted especially on its technology quality globally. Notable studies among them are Lallmahamood (2007), Rusu and Shen (2011), Hsu and Chang (2013), Jeung-tai, and Chihui, (2009) among others. However, Ringim (2013) noted that there is yet to be a study carried out on the effect of technology quality of e-banking in JIB Nigeria.

In order to fill in the research gap, this paper was conducted to assess the effect of technology quality on perceived usefulness and ease of use of JIB in enhancing e-banking

efficiency in Nigerian dwindling economy using technology acceptance Model (TAM). Therefore the main objective of this study is to assess the effect of technology quality on perceived usefulness and ease of use of JIB in enhancing e-banking efficiency in Nigerian dwindling economy.

Literature Review

It is important for banks to provide excellent technology quality to their customers especially in the areas of convenience, security and privacy which were the main variables used in this study. Hence convenience, security and privacy were used in this research as the two components of technology quality. Based on this some related literature were reviewed. Lallmahamood (2007) investigated the influence of technology quality of e-banking using TAM. The survey included 500 internet users in Malaysian urban cities, in which the study used multiple regression analysis for data analysis. The main findings from his study showed that, security and privacy were highly correlated with perceived usefulness and perceived ease of use. In addition to that there is significant relationship between perceived ease of use and perceived usefulness.

However, in the study of Rusu and Shen (2011) it was indicated that security and privacy have negative relationship with perceived ease of use and perceived usefulness. Their finding is in disagreement with the findings of Lallmahamood (2007). They also revealed that if a bank ensures security and privacy in their electronic banking, other variables such as perceived ease of use and perceived usefulness shall be considered by customers, while if it is not ensured the opposite will occur. Their results also revealed that there is a statistically significant relationship between perceived usefulness and perceived ease of use. In the same vein, Hsu and Chang (2013) conducted a quantitative research with the objective of extending TAM by including perceived convenience, with total samples of 82 college and senior high school students. The result from their study showed that perceived convenience had a direct and significant effect on perceived usefulness and perceived ease of use.

Similarly, Jeung-tai, and Chihui, (2009) conducted a research by extending TAM with perceived convenience along with innovativeness and examined the impact of technology quality of e-banking. Their study comprised of 181 valid respondents. Their main findings revealed that perceived convenience is significantly related to perceived ease of use. This is similar to the findings of Hsu and Chang (2013), who revealed that perceived convenience has direct and significant effect on both perceived usefulness and the perceived ease of use.

In the same vein, the study of Njuguna, Ritho, Olweny, and Wanderi, (2013) revealed that perceived usefulness and perceived ease of use share a significant relationship. Similarly, both perceived usefulness and perceived ease of use significantly influence customers' attitudes towards use, which also influences intention to use. They also showed that the intention to use influences the actual use. Finally they also revealed that user satisfaction was also considered to be related to both perceived ease of use and perceived usefulness.

Methodology

Survey research design was used in the study. The population of interest in this study is all JIB current e-banking customers. Since JIB does not cover the whole of Nigeria, it covers only seven states and FCT. The sample size was calculated as follows. From the updated 2009 population estimate the estimated population of the study area i.e. state with JIB branches was computed as 34,930,001 individuals (Information Nigeria Magazine, 2009). In view of Krejeie and Morgan (1970), argument that a minimum sample size of 384 suffices for a population of a million and above. A sample frame of 500 JIB customers was taken to

determine the number of JIB customers to be chosen. Proportionate stratified sampling technique was adopted. The procedure for calculating a sample size for each state and FCT Abuja, involves dividing the 95% or 50% of population estimate of a given state or FCT Abuja with the total estimated population of the seven states and FCT Abuja and then multiplying the result with the adopted sample size of 500 NIB retail customers. For example the sample size of Borno state is calculated as follows:
3,943,633 × 500 ÷ 34,930,001 = 57

The same procedure was followed in arriving at a sample for the remaining six states and FCT Abuja. Sample size of seven states and FCT Abuja with JIB branches is 340 + 160 = 500.
As shown in table 1.

Table 1: Spread of sample size from the estimated populations of JIB customers from seven states with JIB branches and FCT Abuja in Nigeria.

	Five States with JIB branches	95% of Estimated Population (states with highest Muslims populations)	Sample Subjects
1	Borno	3,943,633	57
2	Gombe	2,236,185	32
3	Kano	8,914,498	128
4	Katsina	5,502,949	79
5	Zamfara	3,096,854	44
	Total of five states	23,694,119	340
	Two States and FCT Abuja with JIB branches	50% of Estimated Population (states with average Muslims populations)	
1	Kaduna State	3,033,281	43
2	Lagos State	7,500,000	107
	Abuja FCT	702,601	10
	Total of two states & FCT	11,235,882	160
	Total	34,930,001	500

Source*:* Developed by the Researcher, April, 2016

In order to obtain the most appropriate respondents who are most conveniently available, a purposive sampling procedure was adopted in this study. Bernard and Bernard (2012) refer to purposive sampling as type of sampling, whereby respondents are selected based on the judgment of the researcher in the study. The research instrument for this study is a survey questionnaire. A total of one thousand five hundred (1500) questionnaires were distributed to all the branches of Jaiz Islamic Bank. Eight hundred and twenty five questionnaires were collected, representing fifty five percent (55%) response rate. Twenty five of them were exempted from the analysis because they were not fully completed. Data obtained from the survey was analysed quantitatively using both descriptive and SEM as inferential statistics.

The Research Model

Technology Acceptance Model (TAM) was chosen as the reference paradigm within which the proposed theoretical framework was developed in this study. The model originally specified by the Fishbein (1967), and extensively analysed and developed by Fishbein and Ajzen (1975) as the Theory of Reasoned Action (TRA). Davis (1985) later modified it and formulated his own model of technology acceptance model in 1985. The model received

broad support in empirical studies of technology acceptance which include Phatthana and Mat (2011); Amin, Rezaei, Abolghasemi, Chen, and Li. (2014); Reid and Levy (2008); Li-Ming, Wai, Hussin, and Mat, (2013); Alalwan, Dwivedi, Rana and Williams (2016).

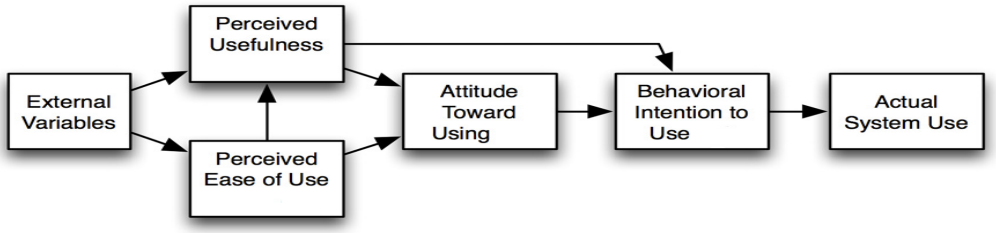
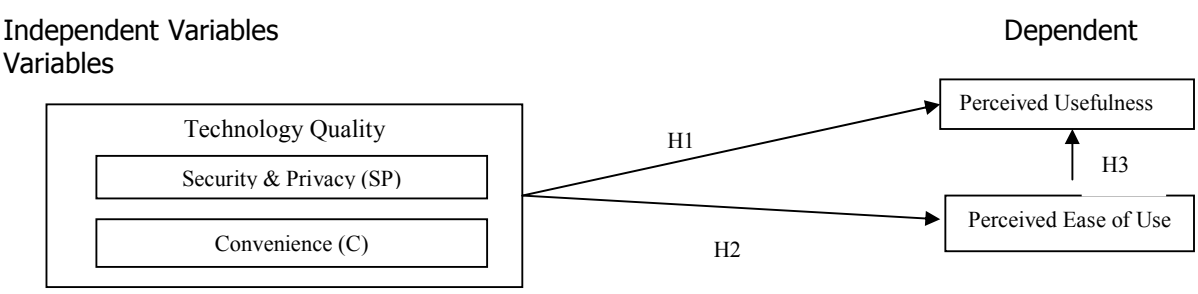


Figure 1: Technology Acceptance Model by Davis (1985)

Research Framework and Hypotheses



Based on the research framework developed for the study the following alternative hypotheses would be tested at 0.05 significance level.

H1: There is significant influence of technology quality (convenience security and privacy) of e-banking on its perceived usefulness among JIB *customers.*

H2: There is significant influence of technology quality (convenience security and privacy) of e-banking on its perceived ease of use JIB customers.

H3: There is significant influence of perceived ease of use on perceived usefulness of e-banking among JIB customers.

Results and Discussions

Table 2: Demographic profile of the respondents

Gender	**Percentage**	**Frequency**
Female	36.6	293
Male	63.4	507
Total	100.0	800
Age	**Percentage**	**Frequency**
18-27	19.0	152
28-37	43	344
38-47	29.6	237
48 & above	8.4	67
Total	100.0	800

Education	**Percentage**	**Frequency**
Islamic school	13.6	109
Primary	8.2	65
Secondary	15.6	125
Diploma/NCE	25.2	202
Degree	23.4	187
Post Graduate	14.0	112
Total	100.0	800
Income (Naira)	**Percentage**	**Frequency**
18000-19999	39.4	315
20000-39999	27.4	219
40000-59999	17.3	139
60000 & more	15.9	127
Total	100.0	800
Occupational category	**Percentage**	**Frequency**
Private Sector	71.0	568
Public Sector	29.0	232
Total	100.0	800

Source: Extracted from SPSS output

SEM was used in this analysis that requires the data to satisfy certain conditions like assessing normality and outliers. First of all descriptive analysis using the mean score and standard deviation was performed. After the descriptive analysis of the various questionnaire items and their associated latent variables their parametric properties is assessed as suggested by Hair et.al. (2010) that normality of the data for this study was assessed with a view to detect the presence of outliers, which may bias the results. The results show absence of multivariate non-normality in our data. The data used is not affected by the presence of outliers. EFA was conducted as presented in table 3 below.

Table 3: Exploratory factor analysis of all variables

Indicator	Factor Loadings Factor Loadings: Variance Extracted: 72.38%, KMO: 0.815, Bartlett's: 709.544 Sig. 0.00				
TQC11	.815				
TQC12	.786				
TQC13	.829				
TQSP17		.765			
TQSP18		.832			
TQSP19		.791			
PU22			.758		
PU23			.845		
PU24			.862		
PU25			.817		
PEOU30				.859	
PEOU31				.818	
PEOU32				.841	

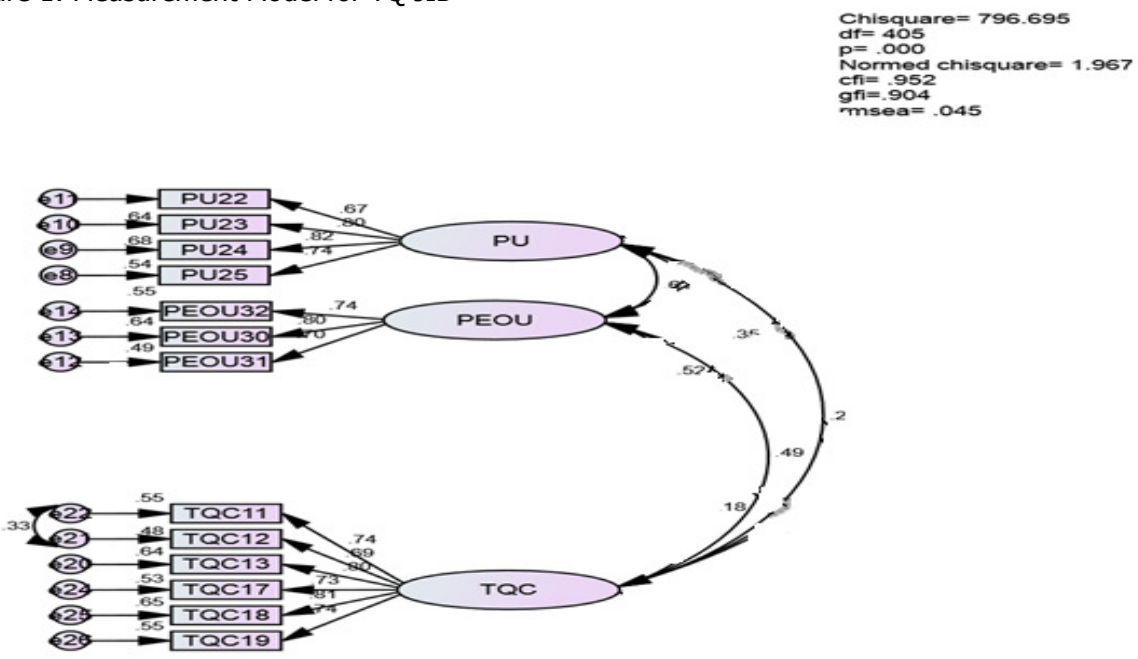
Source: Extracted from SPSS output

Measurement Model of the Constructs (CFA) of Jaiz Islamic Bank E-Banking

Analysis using the structural equation modelling entails two steps to establish the association between the items and relationship among the constructs as extracted during the EFA. The first step is known as the confirmatory factor analysis and the second step is the path analysis. The most commonly used fit indices among the ones mentioned above are CMIN/DF, CFI and RMSEA. According to Wothke and Arbuckle (1996), CMIN/DF with a value of between 2 and 5 is considered acceptable. They further stressed that the threshold values of CFI and TLI range from 0 to 1, with the values that are close to 1demonstrating a good fit (normally above 0.9). Finally, a value of RMSEA of ≤ 0.1 shows a reasonable error of estimation.

The CFI was 0.948 (above the 0.9 minimum), CMIN/DF was 2.057 (below the recommended ≤ 5 cut- off point) and the RMSEA was 0.046 (below the recommended value of ≤ 0.08). All these indicate that the model hypothesized fits the data (Figure 1). The loadings of the items were also examined to see their performances on their respective constructs. All the loading values of the items are more than 0.5 (minimum recommended value) and are all statistically significant, indicating that they are all good measures of their constructs. Therefore, it is concluded that the hypothesized model fits the data as presented in figure 1.

Figure 1: Measurement Model for TQ JIB



A tabular presentation of fit indices criteria compared to the recommended threshold with the observed values of the measurement model is presented in table 4 below:

Table 4: Tabular presentations of fit indices criteria compared to baseline model output

Fit Indices	Recommended Threshold	Observed Values
CMIN/DF	2 ≥ CMIN/DF ≤ 5	2.057
P	P ≥ 0.05	0.000
CFI	CFI ≥ 0.90	0.948
RMSEA	RMSEA ≤ 0.08	0.046

Source: Extracted from Amos output

Convergent and Discriminant Validity of Measurement Model of Use of Nigerian Islamic Bank E- Banking

Table 5: Result of convergent and discriminant validity

Factors	CR	AVE	MSV	ASV
Perceived Use	0.842	0.573	0.462	0.289
Perceived Ease of Use	0.792	0.560	0.774	0.509
Technological Quality	0.890	0.575	0.249	0.160

Source: Authors' computation via statistical tools package developed by Gaskin (2012)

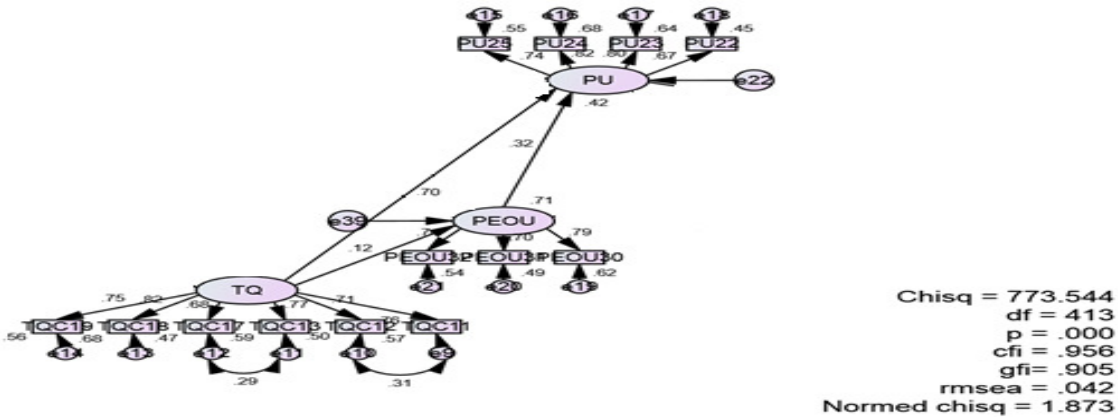
The values in Table 5 above were derived via the statistical tools package developed by Gaskin (2012). The recommended thresholds adopted were also based on those suggested by Gaskin (2012). The average variances extracted (AVE) of all the constructs are more than 0.5, and all the Critical Ratio (CR) is more than 0.7 a condition necessary for convergent validity. However, each construct could not be said to be distinct from each other (discriminant validity) as only one of the two conditions that established this is met by our model (AVE > ASV but not all MSV). It is envisaged that since the theoretical basis for developing each construct is different, the lack of divergent validity should not have serious effect on the final result (Gaskin, 2012). It was advocated that if there is such an issue, a researcher can proceed with the analysis taking cognizance of such lack of divergence provided the variables are used in different contexts within a model and do not generate offending estimates afterward in both the measurement and the structural models (Gaskin, 2012).

Structural Model for Technology Quality of JIB E-Banking

As noted earlier, analysis using structural equation modelling involves two stages-measurement model and path analysis structural model. The hypothesized structural model for this study was analysed using maximum likelihood method in AMOS software with the same criteria as stated above: the chi-square test, the comparative fit index (CFI), and the root mean square error of approximation (RMSEA).

In addition, the path coefficients were examined for statistical significance at $p < 0.05$; and practical significance at path loading of ≥ .20. Examining the factor loadings, all the items are well loaded on their factors, having the values range from 0.63 to 0.85, well above 0.5, which is the cut-off point. Then the researcher checked the fit indices to see how well the model fits the data. As presented in Figure 2 the chi-square is significant, $\chi 2$ (422) = 1238.851, p =0.000, normed chi-square, 2.936 (within the acceptable value of <5), CFI, .901 (within the acceptable value of ≥0.9) and RMSEA of .062 (well within the recommended value of ≤ 0.08). This shows that the model fits the data collected without having to revise it an indication of a good model. Figure 2: below presents the structural model for actual use of Nigerian Islamic Bank e-banking**.**

Figure 2: Structural Model for Technology Quality of JIB E-Banking



Having established the goodness of fitness of the model, the next thing is to examine the path coefficient for practical and statistical significance. As observed earlier, a path (causal relationship) is practically significant if the path coefficient is greater than or equal to 0.2. Statistical significance is established with t-value that reaches the level of significance at p<0.5. Altogether, there are three paths specified in the model; two are both practically and statistically significant. These are paths from the Technological Quality to Perceive Ease of Use and from Perceived Ease of Use to Perceived Usefulness. The path from Technological Quality to Perceived Usefulness is not significant. A tabular presentation of fit indices criteria compared to the recommended threshold with the observed values of the structural model is presented in table 6.

Table 6: Tabular presentation of fit indices criteria compared to baseline model output

Fit Indices	Recommended Threshold	Model Output
CMIN/DF	2 ≥ CMIN/DF ≤ 5	2.936
P-value	P ≥ 0.05	0.000
CFI	CFI ≥ 0.90	0.901
RMSEA	RMSEA ≤ 0.08	0.062

Source: Extracted from Amos output

Table 7: Regression weights of the structural model

			Estimate	S.E.	C.R.	P	Label
PEOU	<---	TQ	.120	.048	2.692	.001	par_34
PU	<---	TQ	-.054	.061	-1.007	.314	par_3
PU	<---	PEOU	.318	.119	2.757	.006	par_4

Source: *Extracted from Amos output*.

In accordance with the extended TAM, this study discussed the research findings of the effect of technology quality on perceived usefulness and ease of use of JIB in enhancing e-banking efficiency in Nigerian dwindling economy where some points were emphasized as follows.

H1: There is significant influence of technology quality (convenience security and privacy) of e-banking on its perceived usefulness among JIB *customers.*

The results of regression weight of the structural model on Table 7 are the evidence of the positive influence of technology quality on perceived usefulness. However the value of path loading between technology quality and perceived usefulness, which is a negative value (-0.054) shows that the quality of technology is statistically insignificant in terms of its impact on the perceived usefulness. The result also revealed the statistical significance of the parameter factor loadings which show that the standardized direct effect between the two variables is statistically insignificant with a value of -0.054 and critical ratio of -1.007 which does not satisfy the threshold stipulation (CR >1.96). This means that the data failed to support hypothesis, thus, H1 was not supported.

The inconsistency between the result and the prediction was proven by the non- significant path estimates towards perceived usefulness. This confirmation is a clear indication that technology quality is a critical factor in enhancing the efficiency of JIB's e-banking, but have no influence on the customers' perceived usefulness of the bank e-banking. However, the strong loadings of the items of the construct - technology quality, confirmed its important contribution to the fitness of the whole measurement model. This means that even though the technology quality of JIB is positive, it is not statistically significant.

The findings of this study contradict the previous findings of Lallmahamood (2007); Hsu and Chang (2013) and Jeung-tai, and Chihui, (2009) in which bank technology quality was discovered to have provided security and privacy and convenience and also improve positively on customer perceived usefulness. The common explanation for the disparities or inconsistencies between the findings of the present study and previous ones is linked to the environment where these studies were being conducted. Most of those studies were conducted in Taiwan, Malaysia and China, where their technology quality of their e-banking are in excellent condition.

In Nigeria, wherein the optimum utilization of e-banking technology has been circumvented by a series of environmental uncertainty, contributed tremendously to gross disparity between findings of this present study and the previous ones. The result of this study is however supported by the study of Rusu and Shen (2011). Their study indicated there was no significant relationship between technology quality and the perceived usefulness of technology.

H2: There is significant influence of technology quality (convenience security and privacy) of e-banking on its perceived ease of use JIB customers.

Regarding the effect of technology quality supporting perceived ease of use, findings showed that the hypothesized model is supported by the data. (Coefficient (β=.120; CR=2.692; P = .001<.05), Therefore Hypotheses H2 was supported. This result is in line with previous findings of Lallmahamood (2007). It is also consistent with Hsu and Chang (2013) and Jeung-tai and Chihui (2009) who found in their studies that excellent technology quality provides ease of use benefits such as easy transfer, time saving, less cost as well as speedy transaction which are related to transaction. On the other hand, findings of this study contradicts the result of Rusu and Shen (2011), in which technology quality does not influence perceived ease of use.

H3: There is significant influence of perceived ease of use on perceived usefulness of e-banking among JIB customers.

There is a direct positive significance relationship between perceived ease of use and perceived usefulness. The consistency between the result and the prediction was proved by positive and significant path estimates which is as follows (β=.318; CR= 2.757; P = .006 <.05), Thus, Hypothesis 3 was supported. The implication of this finding is that customers' perception about the ease of use of e-banking efficiency in JIB greatly influenced about 32% the usefulness perceived therein. This result is supported by the findings of Njuguna et.al, (2012) Lallmahamood (2007) and Rusu and Shen (2011) their studies indicated that perceived usefulness is a major determinant of perceived ease of use. However, findings of this study contradict the result of Al-Somali, Gholami, and Clegg, (2008) who proved that perceived ease of use did not significantly influence the perceived usefulness of the customers' in his e-banking study.

Conclusion and Recommendations

In conclusion, accordance with the extended TAM, this paper summarized the findings of effect of technology quality on perceived usefulness and ease of use of JIB in enhancing e-banking efficiency in dwindling economy. It is revealed in this study that the result of the structural equation model shows a good model fit (Figure 2). Out of three hypotheses in the study, two were substantiated while the remaining one was rejected for failure to support the model and its non-significant influence.

On the general recommendations it is highly suggested that JIB improvement on quality of its technology is crucial as this can enhance the actual use of its e-banking, and also the way the customers perceived the usefulness of its e-banking in Nigeria dwindling economy. Offering secured and excellent technology quality services that measure up to customers' preference are prominent problems in the modern banking industry. However, these duo technological services are highly necessary for the bank to be competitive amidst stiff competition and globalization that are growing in the banking sector in order to improve Nigeria dwindling economy.

Secondly there is significant influence between technology quality and perceived ease of use. This means as Jaiz Islamic banks increases its technology quality, their customers' perception on how easy it will increase significantly. Therefore this is the reason why JIB should put more efforts on improving its technology quality so that people will develop positive perception on how easy it is to use their e-banking products and services. Similarly since the percentage of perception about the ease of use of e-banking in JIB is small therefore in order to enhance efficiency in this dwindling economy this is why it is recommended that the bank needs to simplify its e-banking services so that customers can change their perception about the ease of use of e-banking.

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THE ROLE OF QUALITY ASSESSMENT IN IMPROVING TECHNOLOGY COMMERCIALIZATION IN NIGERIA: THE CASE OF ENGINEERING FACULTIES IN UNIVERSITIES IN IMO STATE

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Abstract
Technology commercialization is an important strategy in a dwindling economy. Quality assessment is a veritable tool in the achievement of technology commercialization. This study therefore, addressed the need for quality assessment of engineering students towards achievement of technology commercialization. One hundred and twenty (120) engineering lecturers from the Federal University of Technology Owerri (FUTO) and the Imo State University Owerri IMSU were used. Four research questions guided the study. A questionnaire of four-point rating scale was developed for data collection. The instrument was validated by four engineering lecturers from FUTO and IMSU as well as two experts in Educational Measurement and Evaluation. The reliability of the instrument was ascertained using a test-re-test measure and a coefficient of 0.83 was obtained. Mean and standard deviations were used to analyze the data collected. The findings reveal that Students Industrial Work Experience Scheme (SIWES) was effectively assessed by engineering lecturers. Another finding was that both seminar presentations and workshop practicals were not adequately and effectively assessed by engineering lecturers. The paper therefore, recommends that engineering lecturers should appreciate the need to do the needful in evaluating students seminar presentations and workshop practicals because of the role quality assessments play towards equipping engineering students with skills that will encourage technology commercialization. Also recommended was the need for Governments to adequately fund universities so that workshop practicals will be adequately and timely funded by the universities.

Introduction
Education is the bedrock for any meaningful development. Be it human, family, political, social, economic development, education plays vital roles. According to Sustainable Development Commission (2004), Education is a "framework for redefining progress and redirecting our economies to enable people to meet their basic needs and improve their quality of life, while ensuring that the natural systems, resources and diversity upon which they depend are maintained and enhanced both for their benefits and for that of future generations." With this, it then means that education can empower a person thereby making it possible for him to define his life and his world. To acquire knowledge, an individual goes through schooling where human, materials and environmental requirements are put in place to achieving this goal. The human requirements are the teachers, lecturers, tutors, instructors and technicians who go through the contents with the learners. Materials and equipments such as, laboratories, studios, and consumables are usually needed in the pursuit of knowledge through education. Of course there is the need for enabling environment such as classrooms, good seating spaces, tables, chairs, ventilation, good lighting. All these put into place should enhance teaching-learning. Teaching and learning is not complete without evaluation. Evaluation of learning is achieved through the use of assessments. These series of assessments according to Onyeka and Dara (2016) is achieved

through the use of different assessment procedures. With this in mind, the teacher is expected to periodically assess the learner during an exposure to a unit of course (formative evaluation) or at the end of term or semester (summative evaluation).

Assessment of learning is an important tool employed by any good educator to monitor teaching and learning and is achieved through different methods such as the use of quizzes, testing, seminar presentations, workshop practicals, use of assignments. Whiston (2000) maintained that any method of assessment employed by an evaluator should be valid. This helps the educator to ascertain if objectives of the units are being achieved or not since the main aim is to monitor teaching and learning. The information gathered quickly leads the teacher to take certain decisions for example to re-teach, change teaching skills or approaches where necessary as well as to provide individualized and remedial instruction. All these are geared towards making the learner 'strong' at the end. Where an educator fails to do this, the outcome could be disastrous. Summative evaluation comes at the end and mainly used to ascertain mastery at this point and also used for certification. At this level, judgments are placed on the learners performances. There must be clear-cut statements by the teacher or institution regarding the learner. His grades are stated and remarks made regarding these grades. Here, the learner must know whether he has passed or failed, completed the level and should be promoted to the next level, to graduate or not to graduate. There is a definite statement regarding the learner. To achieve these, quality assessments are important.

Quality assessment connotes assessments that are put in place to ensure that evaluations made regarding a learner are such that cannot mislead the Evaluator. According to Onyeka and Onuekwusi (2016:5), "Quality assessment is the bedrock of any meaningful evaluation." Therefore, for us to categorically take a decision regarding academic achievements, we must make sure that the assessment strategies employed have quality. At any sphere of education, quality assessment remains the ideal thing because learners must be adjudged based on unflawed assessment information. For instance, at the tertiary level, assessments should be such that will enhance the 'making' of a sound and well developed individual that can fit into any society he finds himself.

Tertiary education ushers an individual into careers. At this level, students are gradually getting into adult life. He is being prepared to face the realities and challenges of life. This level determines to a great extent the person's livelihood. Career actualization as well as career progression becomes more realistic at this level. It is pertinent therefore, that assessment of learning is done with the intention of ushering in a 'total' person to the field of work whether for paid employment or self employment. At the end of university education, where mastery has been achieved and internalised, the individual can effectively fit into the society. A cursory observation of what happens at job situations and offices leaves much to be desired. Sometimes, the performances of these graduates' leave one to imagine what transpired during tutelage/pupilage more especially in assessments and evaluation of these graduates. Assessments could come in form of practicals, presentations, term papers, seminar papers and projects. Such careers that are practical oriented like Engineering demands that assessment of learners should to a great extent employ practical assessments.

Engineering is an applied science that deals with the design and construction of machines and general facilities with economy. It is practically oriented and therefore, the products are practically oriented individuals who can innovate, invent and develop machines and general facilities at reduced costs. Good engineering practice has to do with technical activities that ensure that a company manufactures products of the required quality as expected. If this is

achieved during schooling, no doubts the young engineer will contribute in technology commercialization. There are many areas an engineer can function viz; production, construction, food beverages, industries, electrical electronics, agriculture, aeronautics, marine, polymer.

Technology commercialization has to do with inventors employing their skills in order to invent and develop products which could be licensed to another person, groups, institutions and the society at large in order to be self sustained and for the sustainability of the economy at large. Onyeka (2013) is of the view that commercializing technology is a sine-qua-non for emerging economies. Golob in Noorlizawati, Zainab and Astuty (2014) maintain that commercialization of intellectual property or technology transfer has been viewed as engines of economic growth and also deemed important in creating a sustainable entrepreneurial environment. Onyeka (2012) opined that if graduates of engineering are trained to acquire skills that will aid them in commercializing technology they could contribute their quota in ameliorating economic meltdown, employ others as young entrepreneurs so as to assist in achieving the Sustainable Development Goals (SDGs) of vision 2030. In lieu of this, Google.com talking about process in technology commercialization emphasised in step three the need for procedural assessment. Therefore, assessment strategies in the engineering faculties should be such that would make the young engineer an efficient, innovative, astute researcher and developer. This can be achieved through proper assessment of students Industrial Work Experience Scheme (SIWES), seminar presentations, workshop practicals, projects etc. If these exercises are properly supervised and assessed, evaluation made upon them should place the students in a better stand that will enable them do the needful for themselves and the society at large thereby contributing their quota towards technological commercialization. The crux of the matter is that if during tutelage/pupilage, the assessments are not properly carried out, we may be working with flawed information during evaluation of prospective engineers thereby producing half baked engineers. It also means that they will not have much to contribute to dwindling economy like ours more so at this period of economic recession. During convocation ceremonies, universities make declarative statements that the graduands have been found worthy in character and in learning. Fine! Why then should these young engineers not contribute effectively in technology commercialization? Could it be that leaning did not take place? Could it be that poor teaching skills were employed? Could it be that teachings were mostly theorized rather than practicalized? Could it be that the assessment strategies employed in evaluating them were such that were mis-leading? These and more are the worries of these Researchers.

The objectives of the study are:

(i) To determine the level of assessments carried out during students Industrial Work Experience Scheme (SIWES) of engineering students towards achieving technology commercialization.
(ii) To ascertain the level of using seminars in assessing engineering students towards achieving technology commercialization.
(iii) To find out the efficacy of using workshop practicals in assessing students towards technological commercialization.
(iv) To investigate engineering students projects assessment as a reflection of the skills acquired for technological commercialization.

Research Questions

The following research questions guided the study:

(i) What is the level of assessment for engineering students Work Experiences (SIWS) towards achieving technology commercialization?

(ii) To what extent do the use of seminars serve the purpose of assessment of engineering students towards technology commercialization?
(iii) How effective are the use of workshop practicals in assessment of engineering students towards achieving technology commercialization?
(iv) To what extent does engineering students' project assessment reflect the skills acquired for technology commercialization?

Methods

The study is descriptive and so employed a survey descriptive design. A simple random sampling technique was used to select a sample of 120 engineering lecturers from Imo State University and Federal University of Technology Owerri, Imo State. The lecturers were considered to supervise and assess project, seminar presentations, workshop practicals and SIWES and so could effectively respond to the items of the questionnaire. The instrument was a four point rating scale questionnaire of Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD). Another response were Very High Extent (VLE), High Extent (VE), Low Extent (LE) and Very Low Extent (VLE). The responses were weighted 4 points, 3 points, 2 points and 1 point respectively for positively keyed items and the weighting reversed for negatively keyed items. Both the face and content validity of the instrument were ascertained by presenting it to three experts in measurement and evaluation in education and three engineering lecturers, two each from the two universities used in the study. Their corrections and observations were effected. A reliability coefficient of 0.83 was obtained using the test-retest method which shows that the instrument was reliable and could be used for the study. Mean statistics was used to analyze the data and a criterion mean of 2.50 was set for the acceptance or otherwise of the item means and cluster means. Data were presented using tables.

Results

Research Question One: what is the level of assessment of engineering students Industrial Work Experience Scheme (SIWES) towards technology commercialization?

Table 1: Mean and standard deviation of assessment of engineering students Industrial Work Experiences Scheme (SIWES)

S/N	SIWES Assessment		SA	A	D	SD	X	S	Decision
1	My students go through SIWES	n	84	15	15	6	3.48	2.61	+
		nx	336	45	30	6			
2	I adequately supervise them by visiting their SIWES sites	n	30	48	20	12	2.63	1.41	+
		nx	120	144	40	12			
3	During supervision, students are properly assessed.	n	30	60	15	15	2.88	2.13	+
		nx	120	180	30	15			
4	These assessments help improve their skills	n	39	60	3	18	3.00	1.91	+
		nx	156	180	6	18			
5	SIWES desk officers at the sites do the supervision and assessment	n	15	72	12	21	2.68	1.42	+
		nx	60	216	24	21			
6	Students are not found at SIWES sites and therefore no assessments	n	36	12	42	30	2.64	1.82	+
		nx	144	36	84	30			
	CLUSTER MEAN = 2.94								

Results in table 1 indicated that engineering lecturers make effective use of SIWES in assessing students. The cluster mean is 2.94 with all the item means exceeding 2.50 which was set for the acceptance or otherwise of the mean values.

Research Question Two: To what extent do seminars serve the purpose of assessment of engineering students for technology commercialization?

Table 2: Mean and standard deviation of the extent of use of seminars in assessment of engineering students

S/N	SIWES Assessment		VHE	HE	LE	VLE	X	S	Decision
1	I realize that seminars are good strategies for effective assessment	n nx	66 264	36 108	06 12	12 12	3.30	1.79	+
2	Periodic seminar presentations are proper assessed.	n nx	20 80	40 120	18 36	42 42	2.32	1.37	-
3	Time factor is a hindrance to assessment of seminars.	n nx	15 15	69 138	27 87	9 36	2.30	2.10	-
4	Students are not usually prepared for seminars and therefore no assessment. **CLUSTER MEAN = 2.40**	n nx	75 75	20 40	12 36	13 52	1.69	1.34	-

The analysis in table 2 shows that the lecturers do not make adequate and effective use of seminars in assessment of engineering students since the cluster mean for the research question is 2.40 with all the item means falling below the criterion mean of 2.50 except item one that has a mean of 3.38.

Research Question Three: How effective are assessments of engineering students towards technology commercialization based on workshop practicals?

Table 3: Mean and standard deviation of assessment of engineering students based on workshop practicals

S/N	Assessment of Workshop Practicals		SA	A	D	SD	X	S	Decision
1	I realise that hands on tools is a suitable strategy for quality assessment	n nx	69 276	30 90	12 24	15 15	3.37	2.11	+
2	Funds are available for students workshop practicals	n nx	9 36	42 126	60 120	09 09	2.43	1.61	-
3	Students procure materials for their workshop practicals.	n nx	27 108	57 171	15 30	21 21	2.75	2.16	+
4	Each workshop practical is properly assessed.	n nx	39 156	42 126	24 48	15 15	2.38	1.88	+
5	Workshop practicals are not properly carried out due to funds and therefore assessments improper. **CLUSTER MEAN = 2.82**	n nx	30 120	33 99	42 84	15 15	2.65	2.26	+

From table 3, it is observed that engineering lecturers realize the need to effectively assess workshop practicals with the cluster mean of 2.82. All the items have means above 2.50 which is the criterion mean except item two with a mean of 2.43.

Research Question Four: To what extent does assessment of engineering students represent the skills required in attainment of technology commercialization?

Table 4: Mean and standard deviation of assessment of engineering students' projects

S/N	Assessment of Project		SA	A	D	SD	X	S	Decision
1	Each stage of students' projects is properly supervised and assessed.	n nx	42 168	39 117	24 48	15 15	3.48	2.31	+
2	Only completed projects are assessed	n nx	36 36	39 78	18 54	27 108	2.30	1.72	-
3	Projects are presented before a panel and scored.	n nx	60 240	27 81	18 36	15 15	3.10	2.42	+
4	Factors such as time and funds hinder proper assessments of projects	n nx	70 70	30 60	7 12	16 64	1.76	1.13	-
5	Students engage others to prepare their projects and therefore, no formative assessments	n nx	70 70	35 70	10 30	05 20	1.58	1.11	-
	CLUSTER MEAN = 2.42								

Results in table 4 indicates that assessment of project by engineering lecturers do not effectively represent the skills required. The clusters mean 2.42. Except item one and item three that obtained means above 2.50, others had means very much below the decision mean of 2.50. This reveals that only completed students projects were accessed, time and funds are hindrances to projects assessment.

Discussion

In research question one, the study sought to find out the level of assessment of engineering students in students Industrial Work Experience Scheme (SIWES). It was revealed that engineering lecturers value the need to carry out proper assessment of SIWES because all the item means and cluster mean were all above the criterion mean. This is encouraging because SIWES is aimed at exposing students to machines and other equipments that are in the industries and the practical application of all the theories of the classroom. It is a skill training programme designed to expose and prepare students of universities and other tertiary institutions for the industrial work situation they are likely to meet after graduation. It is a training programme and if effectively supervised and assessed, the evaluation we make will be able to empower the student engineers with knowledge and skills that will assist them towards technology commercialization. In support of this, Yabatech online informs that the aim of SIWES established in 1973 by the Industrial Training Fund (ITF) is to bridge the gap between the skills which the labour market required with that of those acquired by the graduate students. This of course encourages technology commercialization since it exposes students to the industrial experiences and enable them develop occupational experiences so that they can really contribute their quota to national economic and technological development after graduation.

Another revealing finding is the use of seminar assessments on engineering students. This research question has a cluster mean of 2.40.This is not heart warming that the engineering lecturers do not do the 'right' things towards seminar assessments. Seminar presentations apart from fostering good oral presentation, enables the students to have greater knowledge of the topic since they need to adequately prepare for the presentation. Although, the lecturers realize the need for seminar presentation with an item mean of 3.38, other items reveal sickening findings with very low means. This shouldn't be since those presentations handle topics/units that will make them efficient engineers on graduation. Collaborating, Onyeka, (2011) emphasizes the need for seminar presentations to encourage Biotechnology commercialization by students. This is interesting because these seminars are part and parcel of students' curriculum and should be implemented to the letter if our technology will be commercialized and this lies mostly with the training of vibrant and skilful engineers that will be able to face the challenges and realities of technology commercialization.

Engineering is all about apprenticeship. To do this, observation and hands on tools are eminent. The third research question investigated assessment of engineering students' workshop practicals. The finding here is impressive with a cluster mean of 2.82. All the items had their mean values above criterion mean except the item that sought to ascertain the level of hindrance associated with funding of workshop practicals. These workshop practicals are very important if these prospective engineers would adequately perform on graduation. According to Onyeka (2012) students competence in handling works in engineering is a step in the right direction towards technology acquisition, since this finding reveal that engineering lecturers employ varied assessment strategies in evaluating engineering students' workshop practicals. This of course, will empower them with such skills that will encourage them towards achieving technology commercialization.

The fourth research question sought to ascertain level of assessment of engineering students' project towards achieving technological commercialization. This finding was discouraging because the cluster mean fall below the decision mean. Project writing is a veritable means of allowing students discover things themselves under the supervision of a supervisor as Onuekwusi and Onyeka (2017) are of the view that projects are means to internalizing experiences. Project writing is rigorous and therefore requires the patience of both the supervisor and the supervisee. The students in agreement with the supervisor decide on the topic and the student is encouraged to get on. For students of engineering, project writing is very important because hands on tools is the bone of contention. It is surprising therefore, that engineering lecturers are not living up to expectation in this regard. These projects if properly supervised and assessed may become a start-up for these perspective engineers towards technology commercialization. Google search upholds that if engineering projects are fully and effectively assessed, the students will easily enter into the world of work, whether paid or self employed. This also means that they will be able to contribute to technology commercialization.

Conclusion

The objective of this study was to find out if engineering lecturers in the two universities in Imo State employ assessment strategies that could effectively lead to students' involvement towards technology commercialization. The four assessment areas studied were; use of SIWES, use of seminar presentation, use of workshop practicals and assessment of students projects. The findings showed that assessment of SIWES and assessment of workshop practicals are effectively assessed while assessment of seminars and projects are not encouraging. Recommendations were therefore made based on these findings.

Recommendations

Based on the findings of the study, the following recommendations are made:

(i) Engineering Lecturers should continue to appreciate the need for proper assessment of Students Industrial Work Experiences Scheme (SIWES) as a veritable tool for acquiring skills for technology commercialization.

(ii) Engineering lecturers should endeavour to employ assessment of seminars by students as a move in the right direction for technology commercialization.

(iii) Engineering lecturers should employ varied assessment techniques that will further enhance adequate evaluation of the students.

(iv) Government should fund institutions so as to enable the institutions fund Engineering faculties more especially in the area of students workshop practicals.

(v) Engineering lecturers should realize the need to properly supervise and assess their students' projects because when they 'do it themselves', they tend to retain what they have learnt and therefore could transfer the knowledge to technology commercialization.

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ROLES OF CONCEPT MAPPING INSTRUCTIONAL STRATEGY ON ACHIEVEMENT AND RETENTION OF LOW-ACHIEVING BIOLOGY STUDENTS IN SENIOR SECONDARY SCHOOLS IN MINNA METROPOLIS

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Abstract
The study investigated the roles of concept mapping instructional strategy on achievement and retention of low-achieving Biology students in senior secondary schools in Minna Metropolis. Quasi experimental design was adopted in the study. A sample of 86 low - achievers of secondary school (SS1) from two senior secondary schools in Minna Metropolis were used for the study. The instrument used for data collection was the Biology Achievement Test (BAT) and was validated by experts in Science Education, Biological Science experts and Biology teachers. The internal consistency was determined using Pearson Product Moment Correlation formula to be r=0.85. The results indicated that there was significant difference in the mean achievement scores of low-achieving Biology students taught using concept maps and those taught using conventional lecture method. Based on these findings, it was concluded that the use of concept maps was more effective in enhancing low-achieving students' achievement in Biology than the conventional lecture method. It was recommended that re- training of teachers on the use of concept mapping instructional strategy to enhance the achievement and retention of low-achieving Biology students should be encouraged.

Keywords: Concept, Mapping, Concept Mapping, Achievement, Retention, Low-Achievers.

Introduction

A concept map is a graphic organizer which uses schematic representation hierarchically to organize a set of concepts, connected by means of words in order to build meaningful statement. It shows meaningful relationship between concepts in the shape of propositions and it reveals each student's comprehension and knowledge structure (Novak & Gowin, 1999). Concept mapping is a way to help students and educators to see the meanings of learning materials". It reveals the way in which we could assimilate the concept structure with the source of knowledge, on which the map prepares when it is made by a working group and being shared by all students, it gives colorful pressure of their reflexive thought (Novak & Gowin, 1999). And it can become an excellent process of building knowledge in a social environment that is cooperative and constructivist. Concepts maps are vital tools for a cooperative activity that will lead to a very meaningful learning (Novak, 2002). The desire to improve science achievement through the use of more effective instructional strategies and the increasing awareness in recent years of teaching –learning processes has directed to a lot of attention to understanding of how student learn. The efforts in assisting the learner to learn have led to the development of meta-cognitive strategies to enhance meaningful learning (Umaru, 2010). Umaru (2010) attributed students' failure to perform well in external examinations in science and other related disciplines to their inability or lack of interest and competent towards science subject as they assume them difficult to pass. Conversely, Ndioho (2007) noted that student's positive attitudes to science correlate highly with their science achievement especially among low-achievers.

Udeani (2006) defined low-achiever as one who has reached his potential and yet achieves quite poorly in school subjects. Umaru (2010) maintained that slow learners are those who perform below average in school subjects. Furthermore, Jegede (1990) point to the fact that Nigerian secondary school Biology teachers lack the necessary skills in diagnosing and teaching slow learners of the subject. Most of these teachers continue to teach learners with the same methods and instructional materials as if all students' can study and understand at the same rate. Ossai (2004) in a review of research in Biology education in Nigeria reported that 50% of secondary school Biology students in Nigeria are slow learners more importantly amongst gender.

Previous work by Okebukola and Jegede (1988) report that gender difference in science achievement, males perform better than females. Although over the past few decades, the wide gap in science performance between male and female students has been considerably been reduced but these gender gaps still persist. Many reasons have been ascribed for these differences, one of it is over dependent on traditional method of teaching. Udeani (2006) maintained that concept mapping instructional strategy is an effective method of presenting science to the students to achieve meaningful learning. In general, research evidence shows that concept mapping strategy is useful in teaching high cognitive levels as it allows peers to share ideas, seek consensus and compromise willingly with each other and remain open to new insight. Kalu-uche (2010) observed that concept mapping strategy involving collaboration reduces the social factors such as the home, environment, age, sex, and enhances conceptual change in students, thus leading to meaningful learning. In this way, it severs as a meta-knowledge and meta-learning tools, the heuristic of concept mapping a kind of meta-cognitive strategy that assists students in understanding the relationships between them, and in seeing the hierarchical, conceptual, propositional nature of knowledge, in Biology (Umaru, 2010).

Biology is a natural science concerned with the study of life and living organisms, including their structure, function, growth, evolution, distribution, and taxonomy. Modern Biology is a vast and eclectic field, composed of many branches and sub disciplines. However, despite the broad scope of Biology, there are certain general and unifying concepts within it that govern all study and research, consolidation it into single, coherent fields. In general, Biology recognizes the cell as the basic unit of life, genes as the basic of heredity and evolution as the engine that propels the synthesis and creation of new species (Udeani, 2006).

The importance of Biology includes, understanding our bodies from genetics to physiology, many branches of Biology have much to tell us about what the human body is made up of, how it works and how it is affected by what we eat, the air we breathe and every other aspect of the world around us. It also helps us prevent, cure, and even eliminate disease. Biology as a whole is one of the corner stone of all forms of modern healthcare. The field known as pharmacology is literally medicine, it deals with researching and creating everything from over the counter pain relievers to prescription drugs for depression. Jegede, Alaiyemola and Okebukola (1990) in a study compared the effectiveness of teaching two Biology topics using maps and expository method on students in a model school. The results indicated that mapping strategy lowered the students' anxiety level, though there was no significant difference in achievement between the two groups. Males performed better than females.

Kalu-Uche (2010) investigated the effect of concept mapping on student's performance and attitudes towards Biology in Rivers State Nigeria. The students taught Biology using concept maps showed greater improvement in their performance than those taught using lecture

methods in the Biology Achievement Test (BAT). There was a significant difference between the pretest and posttest performance of male and female students towards biology. Students' attitudes towards Biology improved after they were taught using concepts maps which may be a veritable tool on gender achievement.

Gender issues in Biology education were first brought to the wider attention of the research community in the 1970s (Aiyedum, 2000). Much researchers such as, address females to be disadvantageous with respect to achievement, participation, and affective outcomes (Udeani & Okafor, 2012; Umaru, 2010). It became evident in the late 1990s that in some countries, including Australia, the gender gap appeared to be unequal with respect to achievement. For some affective measures, anticipated gender-stereotyped results, based on previous research, have been challenged (Udeani, Lederman, & Umaru, 2010). Late in the 1990s, educational issues with respect to boys surfaced and became a funding focus in Australia and the UK. Boys' literacy levels are well below girls' and research and funding attention to this was fully justified. However, boys were not disadvantaged with respect to Biology and science, particularly with respect to participation rates (Udousoro, 2011) and males remained more advantageous than females (Udeani & Okafor, 2012).

This study was propelled by poor performance of low-achieving Biology students in senior secondary school in Minna Metropolis. This development indicates a significant breakthrough in science education research in the identification and creation of a learning environment where all students can learn equally and effectively too. However, a question may be asked as whether these instructional approaches will produce the same effects on students in their study of different school science subjects especially Biology which in the focus of this study. The teaching strategies that have been adopted to teach low-achievers has not yielded substantial record of performance, hence a more interactive strategy that will salvage the persistent decline in the performance of this group of learners became imperative. Therefore, the strategy that was considered to salvage the problem may be the use of concept maps, hence the study investigated the roles of concept maps on achievement and retention of low-achieving Biology students in Minna Metropolis.

Research Questions

The following research questions were raised to guide this study:

(i) What are the differences in the mean achievement scores of low-achievers in Biology when exposed to concept mapping instructional strategy?

(ii) Would there be any differences in the mean achievement score by gender of low-achievers in Biology when exposed to concept mapping instructional strategy?

(iii) What are the differences in mean the retention scores of low-achievers in Biology when exposed to concept mapping instructional strategy?

(iv) Will there be any differences in the mean retention scores by gender of low-achievers in Biology when exposed to concept mapping instructional strategy?

Research Hypotheses

The following null hypotheses were formulated and tested at 0.05 level of significance;

Ho_1: There is no significant difference between the achievement scores of low-achievers exposed to concept mapping instructional strategy and those exposed to conventional lecture method.

Ho_2: There is no significant difference between the achievement scores of male and female low-achievers exposed to concept mapping instructional strategy.

Ho_3: There is no significant difference between the retention scores of low-achievers exposed to concept mapping instructional strategy and those exposed to conventional lecture method

Ho_4: There is no significant difference between the retention scores of male and female low-achievers exposed to concept mapping instructional strategy.

Methodology

The research design adopted for this study was quasi-experimental design. Specifically, pretest, posttest, non-equivalent, control group design (Udeani & Okafor, 2012). This design was adopted to avoid disruption of the class arrangement, programmes and routines, therefore, intact classes were used for the study. Thus, Senior Secondary one (SSI) classes were used as experimental and control groups. The independent variable is the teaching method while the dependent variables are achievement and retention. The experimental and control groups were given the pretest, posttest and retention test. Experimental group was subjected to treatment using concept mapping strategy and the control group was taught using conventional lecture method. The research design layout is shown below.

Table 1: Research design layout

Group	Pre-Test	Treatment	Posttest	Retension
Experimental Group	O_1	X	O_2	O_3
Control Group	O_4	-	O_5	O_6

Where,
O_1, O_4 - Pretest scores of experimental and control group; O_2, O_5 - Post test scores experimental and control group; O_3, O_6 -Retention scores of experimental and control group.
X - Concept Mapping Strategy (CMS). - No Treatment (CLM).

Population of the Study

The population for this study was all Senior Secondary School low-achieving Biology students in Minna Metropolis totaling 4,275 in Coeducational schools in Minna Metropolis in 2016/2017 academic session.

Sample and Sampling Techniques

The sample used for the study was 86 students drawn from two Senior Secondary Schools, the two schools were randomly sampled from nine schools in the Metropolis. The two schools used were randomly assigned to experimental and control group. Experimental school had 46 students of which (25 males and 21 females) and control school had 40 students (22 males and 18 females). In identifying the low-achievers the researcher used the students' academic records and teachers rating inventory collected from their form masters and were grouped into three subgroups, namely, high, average, and low-achieving students. Those whose scores ranged between 35%- 49% were selected and used for the study. This categorization was done on Niger State categorization platform (2015-2016). The total number of the low-achievers was 12 students in experimental school (7 males and 5 females), while the control group made up of 15 students (9 females and 6 males) respectively.

Instrumentation

Two instruments were used for the study. The instruments include: (i) Concept maps, developed by the researcher in collaboration with an expert in Science Education and (ii)Biology Achievement Test (BAT). The topic was photosynthesis in plant (Mechanisms of photosynthesis, materials, conditions necessary for photosynthesis and importance of

photosynthesis). It consisted of 20 item multiple choice objective questions. The questions were used for pre-test, post-test, and retention test respectively which consisted of four options (A-D) of which one of the option is the only correct answer. The items were developed based on the test blue print as shown on table 3.2.

Table 2: Tables of specification for biology achievement test (BAT)

Levels/ Topics	Knowledge	Comprehension	Application	Analysis	Synthesis	Total
Topic 1	4	3	2	1	-	10
Topic2	4	3	2	1	-	10
Total	8	6	4	2	-	20

Validity of the Instrument

The concept map was validated by three experts from the Department of Science Education, two from the Department of Biological Science, Federal University of Technology, Minna and four Biology tutors from Bosso Day Senior Secondary School. The BAT and making schemes were also subjected to face and content validation. The extracted content materials were used in preparing concept-maps. This consisted of lesson notes, concept map on photosynthesis. The face validity focused on the logical arrangement of the items.

Reliability of the Instrument

To determine the reliability of the instrument, pilot test was conducted using test, re-test method on a school that was within the study area, but not used for the study. The first test was administered to the students and the result was collated. After two weeks, the instrument was re-administered again on the same sets of students. The scores of the two sets were correlated and analyzed using Pearson Product Moment Correlation Analysis and the coefficient of 0.85 was obtained.

Method of Data Collection

The research assistants (Biology tutors of the schools used) were trained for two weeks on how to use concept maps and to maintain standard with respect to teacher quality variable. Pretest was administered to the students to determine the entry knowledge of the students before the commencement of the treatment. All the students in the intact classes were then taught using concept maps in two lessons of 40-minute duration each for four weeks. After four weeks of treatment BAT was administered to the experimental and control groups as posttest. BAT was reshuffled and re-administered as a retention test after two weeks of waiting period.

Method of Data Analysis

The data obtained from pretest, posttest and retention tests were subjected to data analysis, t-test Statistics was used to analysis the hypotheses at 0.05 level of significance.

Results

Table 3: Pretest scores of experimental and control groups

Group	N	df	X	S.D	t-value	p-value
Experimental	12		7.92	0.900		
		25			0.642	0.527 ^{NS}
Control	15		8.13	0.834		

NS – Not Significant P>0.05

Table 3 shows t-test comparison between the mean achievement scores of control group and experimental group in the pre-test. The mean and standard deviation of the experimental group are 7.92 and 0.900 while the control group are 8.13 and 0.834. This indicates that there is no significant difference in the mean score (t= 0.642, df = 25, p>0.05). Hence it was established that both experimental and control group were at the same level of entry knowledge before the treatment with concept mapping instructional strategy.

Hypotheses Testing

Ho_1: There is no significant difference between the achievement scores of low-achievers exposed to concept mapping instructional strategy and those exposed to conventional lecture method.

Table 4: t-test results of posttest scores of experimental and control group

Group	N	df	X	S.D	t-value	p-value
Experimental	12		15.25	1.712		
		25			4.053	0.000*
Control	15		12.47	1.836		

*= Significant at P<0.05

Table 4 shows the t-test comparison between the achievement scores of students taught with concept mapping instructional strategy and those taught using conventional lecture method. The mean score and standard deviation of the experimental group is 15.25 and 1.712. The p-value of 0.000 is is less than the alpha level of 0.05 while the control group are 12.47 and 1.846. This result indicates that there is a significant difference in the mean achievement scores of low-achievers taught photosynthesis using concept map than those taught with conventional lecture method. Therefore, hypothesis one was rejected. This implies that students in experimental performed better than those in control group.

Ho_2: There is no significant difference between the achievement scores of male and female low-achievers exposed to concept mapping instructional strategy.

Table 5: t-test results of posttest scores of male and female low-achievers in experimental group

Group	N	df	X	S.D	t-value	p-value
Male	7		15.57	1.813		
		10			0.768	0.462^{NS}
Female	5		14.80	1.643		

NS = Not Significant at P>0.05

Table 5 shows the t-test comparison between the achievement scores of male and female Low-Achievers taught with concept mapping instructional strategy. The mean score and standard deviation of the male students are 15.57 and 1.813 while that of female students are 14.80 and 1.643. The p-value is greater than 0.05 level of significance. Therefore, this indicates that there is no significant difference in the mean achievement score of male and female students taught photosynthesis using concept mapping instructional strategy. Hence the null hypothesis two which states that there is no significant difference between the achievement scores of male and female Low-Achievers taught photosynthesis with concept map was not rejected. This means that male and female performed equally better.

Ho_3: There is no significant difference between the retention scores of low-achievers exposed to concept mapping instructional strategy and those exposed to conventional lecture method.

Table 6: t-test results of retention scores of experimental and control groups

Group	N	df	X	S.D	t-value	p-value
Experimental	12		15.50	1.508		
		25			5.431	0.000*
Control	15		12.47	1.356		

*= Significant at P<0.05

Table 6 shows the t-test results of retention score of low-achievers taught with concept mapping instructional strategy and those taught using the conventional lecture method. The mean score and standard deviation of the experimental group are 15.50 and 1.508 while control group are 12.47 and 1.356. This results indicates that there is a significant difference in the mean achievement score of the low-achievers taught photosynthesis with the concept mapping instructional strategy and those taught using conventional lecture method. The p-value is less than 0.05 level of significance, Therefore, hypothesis three is rejected. This implies that students in experimental groups performed better than control groups at retention test.

Ho_4: There is no significant difference between the retention scores of male and female low-achievers exposed to concept mapping instructional strategy.

Table 7: t-test results of retention scores of male and female low-achievers in experimental group

Group	N	df	X	S.D	t-value	p-value
Male	7		15.86	1.574		
		10			0.987	0.348^{NS}
Female	5		15.00	1.414		

NS: Not Significant at P> 0.05

Table 7 shows the t-test comparison between the mean retention score of male and female low-achievers exposed to concept mapping instructional strategy (CMIS). The mean score and standard deviation of the low-achiever's male students are, 15.86 and 1.574, while that of female students are 15.00 and 1.414. This result indicates that there is no significant difference in the mean retention score of male and female low-achievers taught photosynthesis using concept mapping instructional strategy (CMIS). The p-value of 0.348 is greater than 0.05 level of significance. Therefore, hypothesis four was not rejected. This implies that male and female students retained the concept of photosynthesis equally better.

Discussion

The result of the result of hypothesis one shows that the experimental group did better than the control group. This means that the use of concept map can enhance students' achievement in Biology at Senior Secondary School Level. This result is in line with the findings of Kalu-Uche (2010); Udeani *et al* (2010) which provided evidence attesting to the efficacy of concept mapping in facilitating meaningful learning in Biology. This was achieved due to the knowledge construction features of the concept maps in learning.

The result of hypothesis two shows that there is no significance difference in the mean achievement scores of male and female Biology low-achievers exposed to concept maps. This means concept maps can be used to enhance both the male and female academic

performance. This finding is in line with that of Aiyedun (2000); Udeani *et al* (2012) who found out that there was no significant difference in the performance of male and female students exposed to concept mapping instruction in teaching the concept of ecology.

The results of hypothesis three shows that there is significance difference in the retention scores of experimental and control groups. The results show that the experimental group performed better than the control group in terms of their retention because of the features of concept maps that was used which enabled the students to recall what was taught. This means that the use of Concept maps enhanced the knowledge retrieval of the students. Thus the finding is in agreement to the findings of Miandoab *et al* (2012) who found out that concept maps enhanced students' retention in learning Genetic concepts in Biology.

The results of hypothesis four shows that there is no significance difference in the retention scores of male and female. This means concept mapping instructional strategy can be used to enhance both the male and female academic performance. This finding is in line with the finding of Kalu-Uche (2010). Who found that there is no significance difference between male and female low-achievers in their retention abilities when taught Biology using concept mapping instructional strategy and conventional lecture method.

Conclusion

Concept Mapping Instructional Strategy (CMIS) has a positive effect on the experimental group than control group, Low-achievers taught with Concept Mapping Instructional Strategy (CMIS) has no significant effect on gender achievement, and retention (males and females) in Biology than Conventional Lecture Method (CLM) and concept map has significant effect on retention, the experimental group performed better than the control group.

Recommendations

Based on the findings, the following were recommended:

(i) The concept mapping instructional strategy should be used by Biology tutors as a veritable for teaching.

(ii) The tutors should be trained on using the concept mapping instructional strategy to enhance the achievement and retention of low – achieving Biology in schools.

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META-ANALYSIS OF THE EFFECT SIZES OF COMPUTER ASSISTED INSTRUCTION STUDIES IN SCIENCE EDUCATION

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Abstract

Computers have been in use in facilitating teaching and learning in Nigerian institutions of learning over the years. The study investigated the magnitude of the effects of Computer Assisted Instruction on secondary students' performance in sciences through meta-analysis of the effect sizes of the studies done in Science Education Department, Federal University of Technology Minna. Descriptive survey design precisely using Meta-analysis was adopted in the study. The population of the study consisted of 545 projects conducted in science education department F.U.T. Minna for the years 2006-2015. 78 research reports were selected using purposeful sampling technique considering only CAI studies. The results revealed that the average effect size of Biology across the years was 0.46 (46%), Chemistry was 0.05 (5%), Geography was 0.48(48%), Mathematics was 0.40 (40%) and Physics was 0.57 (57%) across the years. The average effect size of the five basic science subjects was 0.52(52%) which is a large effect size. The study found out that there was no significant difference among the effect sizes based on nature of subjects and there was no significant difference among the effect sizes based on the years of the studies. It was recommended among others that use of CAI should be encouraged in schools as it enhances teaching and learning especially in science subjects. Effect sizes should always be reported in experimental studies to display the quantum of effects of treatments for decision making.

Keywords: Meta-analysis, Computer assisted instruction, Effect size, Achievement

Introduction

Science and Technology are the bedrocks of any structural and physical development in the contemporary world. Apart from the improvements in the standard of living, science and technology have facilitated the development of the developing countries by leading to the improvement of their needs and desire to compete with the developed world in all spheres of life, education inclusive (Brown, 2010).The role of science and technology in making the earth more comfortable for living cannot be overemphasized. One of the objectives of education as prescribed in the National Policy on Education FRN (2004) is to build a self-reliant nation through the greatest use of technological breakthrough. It is obvious that technology over the years has changed the pattern of human life, particularly with the advent and use of computers in education. Computer is a general purpose machine commonly consisting of digital circuitry that accepts (inputs), stores, manipulates and generates (outputs) data as numbers, text graphics, voice, video files or electrical signals, in accordance with instructions called a programme (Pritchard, 2005). When computers are used in presenting learning contents to learners in a class, it is termed to be Computer Assisted Instruction (CAI).

Computer Assisted Instruction is an interactive process and usually involves learning individually as it involves an interaction between learner and computer programmes at ones pace and scheduled time (Curtis, 2013).For decades, CAI have been in use for learning instruction in various institutions of learning with positive feedback. Such studies were collated and reported in the literature using a method of analysis called meta-analysis.

Meta-analysis uses the effect size to summarize results so that each findings is expressed as a standard unit (Coolidge, 2006). Meta-analysis has the capacity to synthesize results from individual studies, provide a means of identifying moderate variables and means to generate a definitive answer to complex issues at it brings together disparate research findings from primary studies and reconcile them (Gay, Mills, & Airasian, 2009). An effect size gives a direct measure of the impact of an intervention in terms of how much difference is found between groups or parts in time relative to the standard deviation of the difference. Effect size is simply defined as numerical way of expressing the strength or magnitude of a reported relation (Gay, Mills & Airasian, 2009). Effect sizes are usually expressed in decimal number. In few occasions, effect sizes appear to be greater than one, but they usually run from 0.00 to 1.00. Positive effect sizes denote that experimental groups did better, while negative effect sizes indicate that control groups dii better.Where the result is 0.00, it simply implies that none of the groups is better, that is to say both the experimental and control groups are equal. The result of a study expressed as an effect size can be more meaningful and more interpretable than whether or not the result is statiscally significant.

Several researches investigated the effectiveness of CAI in teaching and learning at all levels of education over the years. Researchers collated such studies for better inferences. For example, Li and Ma (2010) analyzed 85 independent effect sizes from 46 studies. A positive correlation was found between using computer technology as a learning tool to teach mathematics as opposed to a presentation tool. Tekbiyik and Akdeniz (2010) reported a meta-analysis to determine the overall effectiveness of Computer Assisted Instruction on students' academic achievement in science education from 2001 to 2007 in Turkey. This effect size was interpreted as an average student's achievement moved from the 50th percentile to the 87th percentile in science learning when Computer Assisted Instruction was used. In another report, Larwin (2011) reported meta-analysis of the effectiveness of CAI on students' achievement in postsecondary statistics education in 40 years. The results suggest that the typical average student moved from the 50th percentile to the 73rd percentile when technology was used as part of the curriculum. In a more complex study, Yesilyurt (2010) conducted a meta-analysis of CAI in science and mathematics in Turkey with the total Effect Size E++ = 3.8262 and critical significance level $p < 0.0001$. The results revealed that Computer Assisted Instruction was quite more effective than traditional teaching.

Generally, the use of meta-analysis of effect size has tremendously influence the inferences been made on the effectiveness of CAI on academic achievement and other important traits as reported in several literature.

Since the advent of computers in the early 19th century, they have been in use for several purposes including learning where most often than not, is tagged as Computer Assisted Instruction (CAI). For quite long time, researches were embarked upon as to validate several CAI packages in teaching and learning in schools with several favourable results. There were numerous studies ranging from the use of powerpoints to the use of dev eloped computer packages in different subjects using projectors in the classroom instruction. Many results revealed positive impact of computers on academic achievement with significant effects across subjects (Bello, Wasagu & Kamay,2016; Gambari, 2010; Yaki, 2011; Yusuf &

Afolabi, 2010; & Dafo, Usman & Sadiq, 2015). The question is, how rich or to what extent were those effects? It is obvious that most of the locally based researches do not report effect sizes of the experiments particularly at undergraduate levels. To the best of the researchers' knowledge, no study was carried out to determine the effect sizes of CAI studies in the department. This underscores the need to explore this type of investigation to help reveal the strength of the CAI studies done in the department to serve as an eye opener for other researchers within and outside the locale.

Aims and Objectives of the Study

The Aim of the study was to analyze the effect sizes of Computer Assisted Instruction(CAI) studies in the department of Science Education, Federal University Of Technology Minna between 2006-215. Specifically, the study sought to determine the:

(i) effect size of CAI in Biology across the years
(ii) effect size of CAI in Chemistry across the years.
(iii) effect sizes of CAI in Physics across the years.
(iv) effect size of CAI in Geography across the years.
(v) effect size of CAI in Mathematics across the years.
(vi) effect sizes of CAI in science subjects across the years.
(vii) difference among the effect sizes of CAIs across the science subjects.
(viii) difference among the effect sizes of CAIs across the years.

Research Questions

The following research questions were formulated to guide the studies:-

(i) What is the effect size of Biology CAI studies from 2006-2015?
(ii) What is the effect size of Chemistry CAI studies from 2006-2015?
(iii) What is the effect size of Physics CAI studies from 2006-2015?
(iv) What is the effect size of Geography CAI studies from 2006-2015?
(v) What is the effect size of Mathematics CAI studies from 2006-2015?
(vi) What is the average effect size of the CAI studies in science subjects from 2006-2015 in Science Education Department in Futminna?
(vii) Is there any difference among mean effect sizes of the studies across the science subjects?
(viii) Is there any difference among mean effect sizes of the studies across the years?

Research Hypotheses

The following null hypotheses were formulated :

HO_1: There is no significant difference among the effect sizes of CAI studies across the science subjects from 2006-2015

HO_2: There is no significant difference among the effect sizes of the CAI studies across the years from 2006-2015

Methodology

The study adopted ex-post- factor design. The population of the study comprises 545 CAI studies conducted In the Science Education Department, Federal University of Technology Minna from 2006 to 2015. Purposive sampling technique was used to select 78 previously basic science CAI studies in the department, which include 19 Biology, 2 chemistry, 9 Geography, 26 Mathematics and 26 Physics. Purposive sampling technique is used where randomization is not viable, and when certain characteristic is targeted in the population (Gay, Mills & Airasian,2009). Access to the data for the study was obtained from the Head of the Department and CAI research reports were sorted out from all the projects, theses and dissertations in the departmental library within 2006-2015 and were coded logically. Results of the posttest of each of these research reports were collated and used in calculating their

effect sizes manually across the subjects using mean and standard deviation, effect size formulas as follows :- (t – value : g = $t \times \sqrt{\frac{1}{N_E}+\frac{1}{N_C}}$, for t-test results , for ANOVA : $W^2 = \frac{SSB-(K-1)MSW}{SST+MSW}$, for mean and standard deviation: $g = \frac{\bar{X}_E-\bar{X}_C}{S_P}$, and $S_p = \frac{(N_e-1)\,S_E^2+(N_C-1)\,S_C^2}{(N_e+N_c-2)}$; to establish the effect sizes. Analysis of Variance was used in testing the null hypotheses with the aid of Statistical package for Social Sciences (SPSS) version 22.

Results

Research Question One

What is the average effect size of Biology CAI studies from 2006-2015?

Table 1: Average Effect size of Biology CAI Studies from 2006-2015

S/N	CODE	Year	Effect size
1	011	2010	0.03
2	007	2014	0.81
3	061	2014	0.17
4	014	2014	0.70
5	015	2014	0.04
6	018	2014	4.10
7	020	2014	0.20
8	035	2014	0.03
9	036	2014	0.05
10	037	2014	0.05
11	038	2014	0.32
12	044	2014	0.06
13	050	2015	0.04
14	051	2015	0.75
15	052	2015	0.04
16	054	2015	0.04
17	055	2015	0.02
18	058	2015	0.04
19	003	2015	1.30
Total			**8.79**
Average			**0.46**

Table 1 shows the effect sizes of Biology CAI studies across the years. The effect sizes range from 0.02 to 4.10 and an average effect size of 0.46 (46%) which can be interpreted as a large effect size. This indicates that the use of CAI in teaching Biology has been effective

Research Question Two

What is the average effect size of Chemistry CAI studies from 2006-2015?

Table 2: Average effect size of chemistry CAI studies from 2006-2015

S/N	Code	Year	Effect Size
1	041	2014	0.03
2	065	2014	0.07
Total			**0.10**
Average			**0.05**

Table 2 reports the effect sizes of chemistry CAI studies across the years. The effect sizes reported ranges from 0.03-0.07 and an average of 0.05 (5%).By interpretation, this is but a small effect size.This indicates that the use of CAI in teaching chemistry has not been effective

Research Question Three
What is the average effect size of Geography CAI studies from 2006-2015?

Table 3: Average effect size of geography CAI studies from 2006-2015

S/N	Code	Year	Effect Size
1	016	2014	0.04
2	023	2014	0.04
3	027	2014	0.08
4	034	2014	0.06
5	039	2014	3.50
6	053	2015	0.03
7	056	2015	0.04
8	071	2011	0.50
9	084	2008	0.05
Total			**4.34**
Average			**0.48**

Table 3 reports the effect size of Geography CAI studies across the years. The effect size reported ranges from 0.03-3.50 and an average of 0.48 (48%).This signifies a large effect size. It clearly indicates that the use of CAI in teaching Geography has been effective

Research Question Four
What is the average effect size of Mathematics CAI studies from 2006-2015?

Table 4: Average effect size of mathematics CAI studies from 2006-2015

S/N	Code	Year	Effect Size
1	001	2006	0.07
2	008	2014	3.02
3	009	2006	0.05
4	010	2009	0.04
5	013	2014	0.69
6	019	2014	1.17
7	021	2015	1.30
8	033	2014	0.06
9	042	2014	0.02
10	043	2014	0.40
11	045	2014	0.05
12	046	2014	0.02
13	047	2014	0.03
14	048	2014	0.03
15	059	2015	0.06
16	063	2008	1.84
17	064	2009	0.64
18	066	2010	0.04
19	067	2010	0.03
20	068	2011	0.05

21	069	2011	0.62
22	070	2011	0.03
23	073	2011	0.06
24	075	2012	0.04
25	080	2012	0.03
26	081	2012	0.07
Total			**10.46**
Average			**0.40**

Table 4 shows the effect size of Mathematics across the years and the effect sizes reported range from 0.02-3.02 and an average of 0.40 (40%). This is interpreted as large effect size. By implication, it is clear that the use of CAI teaching Mathematics has been effective.

Research Question Five

What is the average effect size of Physics CAI studies ?

Table 5: Average effect size of physics CAI studies from 2006-2015

S/N	Physics Code	Year	Effect Size
1	004	2010	4.38
2	072	2011	0.09
3	074	2011	0.82
4	076	2012	0.77
5	077	2012	0.04
6	079	2012	0.07
7	082	2012	0.04
8	083	2012	0.04
9	005	2013	1.13
10	024	2014	0.05
11	025	2014	0.04
12	026	2014	0.06
13	028	2014	0.06
14	029	2014	0.14
15	030	2014	0.04
16	031	2014	1.54
17	032	2014	2.23
18	060	2014	0.06
19	062	2014	0.49
20	040	2014	0.04
21	049	2014	0.40
22	057	2015	0.05
Total=			**12.58**
Average			**0.57**

Table 5 shows the effect sizes of physics CAI studies across the years. The effect sizes reported ranges from 0.04-4.38 and an average of 0.57 (57%) which is also interpreted as a large effect size. This is an evident that CAI has been effective in teaching Physics as a science subject.

Research Question Six
What is the effect size of CAI on the Five Basic Science Subjects?

Table 6: Average effect size of the five CAI science subjects

S/N	Subject	Number Of Studies	Total Effect Size
1	Biology	19	8.90
2	Chemistry	2	0.05
3	Geography	9	4.38
4	Mathematics	26	10.43
5	Physics	22	16.85
Total		**78**	**40.61**
Average			**0.52**

Table 6 reports the grand average effect size over the years of the five basic science subjects. The average effect size obtained was 0.52 (52%) which can be regarded as a large effect size. This simply indicates that the use of CAI has been favourable in teaching the five basic sciences.

HO_1: There is no significant difference among the effect sizes of CAI studies from 2006-2015 across the science subjects.

Table 7: ANOVA of the difference in the mean effect sizes of cai across the subjects

	Sum of Squares	df	Mean Square	F-value	p-value
Between Groups	3.56	8	.445	.471	.873*
Within Groups	71.008	75	.947		
Total	74.571	83			

*= Not significant at 0.05

Table 7 shows ANOVA results of the difference in the mean effect sizes based on the subject f (8,75) = 0.471, P> 0.05. Therefore, the null hypothesis is accepted. It implies that there is no significant difference among the effect sizes across the subjects.

HO_2: There is no significant difference among the effect sizes of the CAI studies across the years from 2006-2015

Table 8: ANOVA of the difference in the mean effect sizes across the years

	Sum of Squares	df	Mean Square	F-value	p-value
Between Groups	3.446	8	.431	.454	.884*
Within Groups	71.126	75	.948		
Total	74.571	83			

*=Not significant at 0.05

Table 8 provides ANOVA results of the difference in the mean effect sizes base on the subject f(8,75) = 0.431, P> 0.05,. Therefore, the null hypothesis is accepted. This indicates that there is no significant difference among the effect sizes of the studies across the years.

Discussion

The aim of this study was to determine the effect sizes of CAI studies from 2006-2015 in the department of Science Education, Federal University of Technology, Minna, Nigeria. Results for the research question one shows that the effect sizes of Biology CAI studies 0.46 (46%) which can be interpreted as a large effect size. This indicates that the use of CAI in teaching Biology has been effective. This is in line with the findings of Tekbiyik and Akdeniz (2010) who obtained a large average effect size of 1.12 from 82 CAI studies in science education (Biology inclusive). The subjects moved from 50^{th} to 85^{th} percentile after using CAI.

The results for the research question two indicated average effect size of chemistry CAI studies across the years to be 0.05 (5%). By interpretation, this is but a small effect size. Although the number of the chemistry CAI studies was too small for the analysis (i.e. only two studies),so this could have contributed in getting the small effect size obtained. The result is parallel to that obtained by Tekbiyik and Akdeniz (2010), Yesilyurt (2010) and Liao (2007) who obtained large effect sizes in the meta-analysis of the CAI studies in sciences and Mathematics.

The results of the research question three indicated a large average effect size for Geography CAI studies across the years, 0.48 (48%).This also supports the previous meta-analysis such as Tekbiyik and Akdeniz (2010), Yesilyurt (2010), and Liao (2007) who got a large effect sizes in their analyses of CAI studies. This also clearly indicates that the use of CAI in teaching Geography has been positive.

Research question four yielded an average effect size of 0.40 (40%) in Mathematics CAI studies across the years. As usual, the coraborates that of Tekbiyik and Akdeniz (2010), Yesilyurt (2010), and Liao (2007) who obtained large effect sizes.

The results for the research question five shows an average effect size of 0.57 (57%) for physics CAI studies across the years. This is an evident that CAI has been effective in teaching Physics as a science subject. This in line with the finding of Yesilyurt (2010) who got average effect size of 3.83 in physics CAI studies.It also corroborates those of Haas (2005), Tekbiyik and Akdeniz (2010), Yesilyurt (2010), and Liao (2007) who got a large effect sizes in their analyses of CAI studies in sciences.

Table 6 reports the grand average effect size over the years of the five basic science subjects. The average effect size obtained was 0.52 (52%) which can be regarded as a large effect size. This simply indicates that the use of CAI has been favourable in teaching the five basic sciences. The findings are supported by all the cited studies like Tekbiyik and Akdeniz (2010), Yesilyurt (2010) and Liao (2007).

The null hypothesis one was accepted as there was no significant difference among the effect sizes across the five basic science subjects. This was also in support of the results of who found no significant difference in Biology CAI studies. Thus, nature of a subject is not determinant of a large effect size according to the results of this study.

Also the null hypothesis two was accepted as the results indicated that there was no significant difference among the effect sizes of the studies across the years. So years have nothing to do with the effect sizes of the CAI studies, even though there was little variations in the effect sizes of each year of studies. The results indicated in significant difference across the year

Conclusion

It is obvious from the findings of this study, that the use of CAI is an effective medium of teaching and learning of science subjects, and meta-analytically, the differences in students' performance amongst the experimental and control groups proved to be substantial as most of the results revealed higher performance when CAI was used as revealed by the large effect sizes obtained.

Recommendations

The following recommendations were made based on the findings:-

(i) The use of CAI should be encouraged in schools as it enhances teaching and learning especially in science subjects as established by the effect sizes of this study.

(ii) Meta-analysis should be encouraged on CAI studies and other relevant studies in other tertiary institutions as to have comprehensive information on certain variables and their relationship

(iii) CAI packages should be improved for publications so that secondary schools and also tertiary institutions can access them for teaching and learning activities.

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APPENDIX

EFFECT SIZE FORMULAS

(1) For mean and standard deviation

$$g = \frac{\bar{X}_E \quad \bar{X}_C}{S_p}$$

g =effect size

$\bar{X}_E$ = Mean of the experimental group

$\bar{X}_C$ = Mean of the control group

S_P = pooled standard deviation

The pooled standard deviations is calculated using the following formula:

$$S_p = \frac{(N_e - 1)\, S_E^2 + (N_C - 1)\; S_C^2}{(N_s + N_2 - 2)}$$

S_p = pooled standard deviation

N_e = no of subjects in experimental group

N_C = no of subjects in control groups

S_E = standard deviation of the experimental group

S_C – standard deviation of the control group (Hdges & Olkin, 1985)

N.B. (for mean & standard deviation)

Cohen d = $\frac{Mean\ differences}{Standard\ deviation}$

Interpretation

$0 \longrightarrow 0.20$ = weak effect size
$0.21 \longrightarrow 0.50$ = modest effect size
$0.51 \longrightarrow 1.00$ = moderate effect size
> 1.00 = strong effect size (Cohen, 1988)

(2) For t-test statistics

(a) $\propto = \frac{\sqrt{t^2}}{t^2+df}$

r^2 = percentage of variance explained (effect size)
t^2 = t-value squared
df = degree of freedom (Gravelter & Wallnau, 2005)

(b) t – value : g = $t \times \sqrt{\frac{1}{N_E}+\frac{1}{N_C}}$

g = effect size
N_E = number of subjects in the experimental group
N_C = number of subjects in the control group (Tekbiyik & Akdeniz, 2010)

Interpretation

0.100 = small
0.243 = medium
0.371 = large (Coolidge, 2006)
$0.01 < r^2 < 0.09$ = small effect
$0.09 < r^2 < 0.25$ = medium
$r^2 > 0.25$ = large
(Cohen, 1988, Gravelter & Wallnau, 2005)

(3) For ANOVA

(a) $W^2 = \frac{SSB-(K-1)MSW}{SST+MSW}$

W^2 = omega squared (effect size)
SSB = sum of squares between
SST = sum of square total
MSW = mean squared within

(b) $\eta^2 = \frac{SS\ between\ treatments}{SStotal}$

η^2 = eta squared (effect size)
SSbt = sum of squares between treatments
SS_{tt} = total sum of squares

Interpretation

$W^2 > .15$ = large effect
$W^2 > .06$ = medium effect
$W^2 > .01$ = small effect (Coolidge, 2006)

LECTURERS' AWARENESS, READINESS AND SELF-EFFICACY OF USING PODCAST FOR TEACHING IN TERTIARY INSTITUTIONS IN NIGER STATE, NIGERIA

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Abstract

This study investigated lecturers' awareness, readiness and self-efficacy of using podcast for teaching and learning in tertiary institutions in Niger state, Nigeria. The research was a descriptive type using the survey method. The sample was drawn from three federal institutions and three state colleges of education in Minna Niger State. The sample consisted of four hundred and twenty (420) lecturers from the 6 (six) tertiary institutions. Three Objectives and 3 corresponding research questions were raised to guide the study. An instrument tagged 'Lecturer' Awareness, Readiness and Self-efficacy in Podcast (LARSPQ)' was developed by the researchers. It consists of 31 items structured into four options, and was validated by four experts from Federal University of Technology, Minna, Nigeria. The data obtained from LARSPQ was pilot tested and analysed using Cronbach's alpha, 0.88 reliability coefficient was obtained. Ninety-five percent (95%) of LARSPQ were returned and 90% were used for data analysis. Mean and Standard Deviation were used to answer the research questions. Results of the study showed that lecturers aware of the use of podcasts in teaching, and ready to use podcasts in teaching. It was revealed that lecturers have no adequate knowledge and skills of using Podcast. The study recommends that lecturers should be trained on the use of podcasts for teaching their courses to improve the academic performance of students.

Keywords: *Podcast, Lecturers, Awareness, Readiness, Self-efficacy, Tertiary Institutions*

Introduction

Information and communications technology (ICT) is extending the boundaries to higher education and anywhere at any time. Effective learning takes place through the adoption and utilization of science and technology. Science and technology education form the grassroots for any sustainable national development by guiding against human societies from ignorance, illiteracy, disease and poverty (Owolabi & Omoniyi, 2014).

At this point, Federal Republic of Nigeria in the National Policy on Education (FRN, 2013) stressed that students should be fully equipped to live effectively in this modern age of science and technology, to also possess the mind of scientific and reflective thinking. It is therefore important for lecturers to have the basic knowledge of information and communication technology and its impact on the society at large. The main purpose of science and technology courses is to train individual learners suitable of utilizing the new and current technological discoveries in every field.

E-learning typifies an important element in ICT-technology which helps teachers/lecturers and students become actively engaged together in online collaborative work to assist and help traditional learning methods to be effective (Behera, 2013; Kakbra & Sidqi, 2013). Mobile learning is a form of E-learning because it allow student to study even while travelling (Evans, 2008). Mobile learning can be referred to as a type of learning model

which allows students to get and use learning materials through the use of internet and other portable devices anywhere and at anytime (Lan & Sie, 2010; Ozdamli & Cavus, 2011). Student/learners can request for any information about a specific subject matter on the internet through a mobile mean using podcasting.

Podcasting is very similar to mobile learning because learners can have access to teaching and learning in form of audio or video broadcasts on the move using any mobile device such as tablets, Smartphone's or cell phones. Broadcasts are published and send on the internet and instantly downloaded on to a desktop or laptop computer (Evans, 2008; Madiope, 2013). Podcasting had been considered as a supplementary method in the context of recent mobile learning technologies and applications (Bell, Cockburn, Wingkvist & Green, 2007; Heilesen, 2010).

Podcasting is the process of creation and regular distribution of information through the internet. Podcast includes audio, video, PDF and E-pub files which can be subscribed to and subscribers are then able to watch, hear it and spread the episodes to any types of media players (Hew, 2009). These podcasts are instantly downloaded for playback on mobile devices and/ or personal 'episode'. Thus, episodes in a series form a podcast 'channel', equivalent to that of radio and TV shows/channels. Furthermore, podcasting enables users to quickly and easily download multimedia files, including audio and video, for playback on mobile devices including iPods and other MP3 players (Bausch & Hen, 2006).

Podcasts can be viewed in three forms namely: audio-only podcast, enhanced podcast, and video podcast also known as vidcast or vodcast. Enhanced podcasts combine still images with audio files, audio-only contain audio files and video podcasts contain video files (Liu & McCombs, 2008; Salmon, Mobbs, Edirisingha & Dennett, 2008). Many researchers had accepted podcasting as a new and hot technology with wide possibilities which has capture the attention and imagination of practitioners from all areas of educational system across the globe (Sun, 2008). For instance, in the classroom, podcasting can be used effectively as a communicating tool due to its low cost and effectiveness. It accommodates individual learners with different learning needs (Schmisdt, 2012). Donnell and Berge (2012) identify four unique characteristics of podcasts that makes it interesting to students. First, they include the voice of the developer which makes information more personal than written words alone. Secondly, their inclusion can provide learners with control over their learning by providing them with options such as reading a book, listening to the podcasts, or using both. Thirdly, it makes students to listen to the portable files while engaging in other things. Fourthly, it makes lecturers and students to time-shift instructional materials or informational content.

Educational uses of podcasts was broadly categorized based on its continuum of use and they are: (a). Substitution (podcasts can be used as a substitute to the traditional lecture where students can access an entire recording of the lecture), (b) supplemental (podcasts can provide additional material or support to what is given in class time) and (c) creative (podcasts can be created by students and it helps them become more engaged in the learning through constructing knowledge rather than simply receiving it) (McGarr, 2009; Serry, 2012). Frydenberg (2006) noted that podcasting is very useful in disseminating course and information; its use becomes more beneficial when students are challenged to become creators of the material to be disseminated as well as developing critical thinking skills and the nature of the activity therefore leads to a very engaging and worthwhile learning experience.

Tynan and Colbran (2006) reported that lecturers support the continuation of podcasting because it was very positive as it has been found previously. It had been reported that podcasts have great impact on students' academic performance. McKinney, Dyck and Luber (2009) conducted a study and found that students who attend lecture and also watched podcasts lectures largely outperformed those that attended the lecture without watching the podcasts. Harry and Park (2008) noted that the increasing use of podcasting in education has the potential to significantly change the teaching and learning experience of student. Other researchers have reported using podcasts to record tutorials (Tynan & Colbran, 2006) and deliver short recordings or "episodes" of core (Clark, Taylor, & Westcott, 2007; Laing & Wootton, 2007) or supplementary material (Bell, Cockburn, Wingkvist, & Green, 2007). With these benefits of podcasts, the yet unanswered question is that; are Nigeria lecturers and students really aware of podcasts?

In developed nations, Copley (2007) reported that many faculty members in higher institutions are aware of podcasts and they have started adopting it to deliver supplementary lectures materials for campus-based students. He also noted that podcasting is commonly used for distribution of lectures recorded for learner's to revisit and revise. Level of awareness of podcasts tool remains relatively low in developing countries and this affects the level of integration of ICT into Teaching and learning process. According Conole and Weller (2008) and Panke (2011), for ICT tool to be optimally integrated into teaching and learning process, there is necessity to get teachers and students aware of the existence, readiness to integrate and acquire some skills on the use of ICT tools for teaching. Podcast awareness is a novel while in developed countries a number of studies have been carried out (Abt & Barry, 2009; McKinney et al., Shaw, 2009; Mathison & Billings, 2010; Rezapour,Gorjian & Pakhakh, 2012; Farshi & Mohammadi, 2013; Liao, Chen & Tai, 2013).

For instance, Francom et al. (2011) in their study '' The Effects of Podcasting on College Student Achievement and Attitude" found that podcast had positive effects on the students' performance. Students found the podcasts to be useful in helping to clarify terminology and theoretical constructs, as explained in the following quote from a student comment. Hearing a lecture a second time helps the theory to sink in and get the most out of the lecture. Other researchers have reported using podcasts to record tutorials (Tynan & Colbran, 2006) and deliver short recordings or "episodes" of core (Clark, Taylor, & Westcott, 2007; Laing & Wootton, 2007) or supplementary material (Bell, Cockburn, Wingkvist & Green, 2007).

Elliot, Scutter and King (2009) said that many lecturers have embraced the technology and now routinely podcast lectures. A literature overview of usage from United States universities presented by Deal (2007) affirmed that Podcasts have been incorporated into the curriculum in a variety ways to meet a range of learning objectives. Part of this study aimed at investigating lecturers' readiness to adopt the use of Podcasts in Nigerian tertiary institutions. Apart of from being ready to adopt this technology, what about the skills needed in using it (self-efficacy)?

Self-efficacy is a kind of ability to perform the actions required for success. It can also be viewed as a kind of skill someone has to operate a particular device for operation. Lecturers with high self-efficacy would be expected to put more effort into tasks and be more persistent in their academic pursuits and also in the use of technology (Sander & Sanders, 2006). Bandura (2001), perceived self-efficacy affects an individual in all aspects of life including educational experiences. He also noted that they have low aspirations and weak commitments to the goal they choose to pursue. They fall easy victims to stress and depression. Lee et al. (2008) believe that the true potential of podcasting technology lies in

its knowledge creation value and its use as a vehicle for disseminating learners generated content.

In view of the above, the study therefore investigates lecturers' awareness, readiness, and self-efficacy of using podcasts for teaching in tertiary institutions in Niger State, Nigeria.

Statement of the Problem

The digital age students are addicted to mobile phones for playing games, seeing movies, listening to music, chatting with friends, taking photographs, video and recording of events, among many time wasting activities. The results of these activities have started manifesting in their academic performance. The causes of this problem could be traced to students addicted to mobile devices for entertainments and social activities. The question is how do we curb the menace of mobile addiction or translate it into something meaningful and positive for learning? Incorporating podcast into the classroom settings will subdue the negative tendencies that mobile devices have on students' academic performance and enable them to derive their learning satisfaction through addiction. However, the effective use of podcasting in education is in its infancy in Nigeria. There are few studies that has been carried out in the area of podcasting in Nigeria (Mbah, Mbah, Iloene & Iloene, 2013), especially on the effect of podcasts on the performance of students. Podcast, being a recent technology, it is perhaps understandable that research into the area of podcasting in education is limited in Nigeria. Hence, this study set out to bridge the gap in the literature by investigating lecturer's awareness, readiness, and self-efficacy of using podcasts for teaching in tertiary institutions in Niger State, Nigeria.

Research Questions

The study sought answers to the following research questions:

(i) Are lecturers aware of the use of podcast for teaching in tertiary institution?
(ii) Are lecturers ready to use podcasts for teaching in tertiary institution?
(iii) What is the level of lecturers' self-efficacy in using podcasts for teaching in tertiary institution?

Methodology

Descriptive research design of the survey type was adopted in this study. The population comprised of eleven tertiary institutions in Niger state. A multi-stage sampling technique was used to select samples from target populations for the study. Firstly, simple random sampling technique was used to select six tertiary institutions in Niger State. The population and sample size of the lecturers in selected institutions is 2,492 and 497 respectively as shown in Table 1.

Distribution of Sample Size

Name of Institutions	**No. of Lectures**	**20% from each Institutions**
Federal University of Technology, Minna (FUT)	820	164
Federal Polytechnic, Bida	620	124
Federal College of Education, Kontagora	283	57
IBB University, Lapai	320	64
College of Education, Minna	230	46
Niger State Polytechnic, Zungeru	210	42
Total	**2,492**	**497**

Proportionate random sampling technique was used to select 20% of the respondents from each institution in Niger State, Nigeria. A structured questionnaire was the instrument used for data collection in this study. The questionnaire contained two major parts, (A and B).

Part A dealt with the lecturers' biographical information such as respondents' institution. Part B comprised of three sections (I - III). Section I dealt with statement on 'Lecturers' Awareness on Podcasts Questionnaire (LAQ)'; Section II dealt with 'Lecturers' Readiness on the use of Podcasts Questionnaire (LRQ)'; while Section III dealt with 'Lecturers' Self-Efficacy on the use of Podcasts Questionnaire (LSQ).

Part B of the instrument consists of 31 phrased statements to preclude any response set. A modified four-point Likert scale was used. Section I which requests for information on respondents' awareness on podcast and contains 10 items, with response mode of Fully Aware (FA = 4), Aware (A = 3), Not Fully Aware (NFA = 2), Not Aware (NA = 1), Section II which requests respondents level of readiness to use podcast contains 10 items with response mode of Fully Ready (FR = 4), Partially Ready (PR = 3), Ready (R = 2), Not Ready (NR = 1), Section III which requests information on respondent's self-efficacy on the use of podcast contains 11 items with response mode of Strongly Agree (SA = 4), Agree (A = 3), Disagree (D = 2), Strongly Disagree (SD = 1).

The first draft of questionnaire was given to four senior lecturers from Science Education Department, Federal University of Technology, Minna for content and face validity. The pilot test was conducted in three tertiary institutions in Kwara State to test the reliability of the instrument. A total of forty lecturers of the following schools; College of Education Ilorin, University of IIorin, and Kwara State Polytechnic were selected for the pilot study.

The data thus collected from the pilot study were statically analyzed for the purpose of reliability co-efficient using the Cronbach alpha. Consequently, reliability of 0.88 was obtained. This reliability co-efficient was considered adequate for the internal consistencies of the instruments. Four hundred and ninety seven (497) copies of questionnaire were administered while four hundred and twenty (420) questionnaires were retrieved and used for data analysis. Seventy seven (77) questionnaires were not returned by the respondents after four weeks of distribution. This represent fifteen per cent (15%) questionnaire mortality rate.

Results

Data collected on the basis of the research questions were analyzed using descriptive statistics (mean and standard deviation). The limit for decision rule: An average mean of 2.50 and above was considered as agreed, while an average mean of 2.49 and below were considered disagreed with respect to research questions. A mean of 2.5 according to David (2005) was used as a criterion to judge mean scores for four point item format. Therefore, the mean criterion of 2.5 was calculated from the sum of 4+3+2+1 divided by 4.

Research Question One: Are lecturers aware of the use of podcasts for teaching in tertiary institutions?

Table 2: Mean and Standard Deviation on Respondents on Awareness

S/N	I am aware that:	Mean	SD	Decision
1.	Podcast can be used for teaching in tertiary institutions	3.23	0.89	Agree
2.	Knowledge of using podcasts would assist me in teaching large class of students.	3.19	0.81	Agree
3.	Podcasts could be used to divert students' attention from using Mobile devices for social media and entertainment.	3.09	0.92	Agree
4.	Podcasts could be an effective means of delivering information on Mobile device via Internet.	3.15	0.82	Agree

5.	Podcasts can be used to post multiple choice questions to students mobile device.	3.03	0.91	Agree
6.	Podcasts can be used to create more interaction between lecturers and students.	3.02	0.89	Agree
7.	Video Podcasts (vodcast) could be used to solve some misconception problems in teaching and learning.	3.03	0.88	Agree
8.	The use of Podcasts could help to provide better learning experience and opportunity for students in higher institutions.	3.08	0.84	Agree
9.	Podcasts could be used for collaborative learning among undergraduate.	3.01	0.89	Agree
10.	Podcasts can provide immediate feedback to learning activities.	3.02	0.89	Agree
	Cumulative Mean	**3.08**		

Decision Mean =2.50

Table 2 shows the perception of lecturers' awareness of the use of podcasts for teaching in tertiary institutions in Niger State. It was observed that all the respondents are in agreement with the awareness of using podcasts for teaching in tertiary institutions. This is because the cumulative mean 3.08 is greater than the decision mean 2.50.

Research Question 2: Are lecturers ready to use podcasts for teaching in tertiary institutions?

Table 3: Mean and Standard Deviation on Respondents on Readiness

S/N	Items	Mean	SD	Decision
1.	I am interested in using Podcasts for teaching my courses.	3.06	0.90	Agree
2.	I am ready to use Podcasts to teach when I have the Facilities.	3.26	0.82	Agree
3.	I will like to learn about using Podcasts for teaching.	3.22	0.79	Agree
4.	I am ready to attend workshops and seminars on the use of podcasts for teachingthe use of Podcasts for teaching.	3.26	0.84	Agree
5.	I will use Podcasts for sending lecture materials and assignments to students.	3.09	0.86	Agree
6.	I am ready to interact with my students via Podcasts	3.11	0.89	Agree
7.	I will like to use Podcasts to encourage students in using mobile devices for learning rather than for entertainments and social media.	3.16	0.83	Agree
8.	I am ready to provide immediate feedback to my students request through the use of Podcasts.	3.10	0.86	Agree
9.	I will like to use Podcasts for presenting my lecture in video format.	3.04	0.89	Agree
10.	I am ready to deliver my lecture using Podcasts in audio format.	3.03	0.94	Agree
	Cumulative mean	**3.13**		

Decision Mean =2.50

Table 3 shows the perception of lecturers' readiness for the use of podcasts for teaching in tertiary institutions in Niger State. It was observed that all respondents are in Agreement

with the readiness of using podcasts for teaching in tertiary institutions. This is because the cumulative mean 3.13 is greater than the decision mean 2.50.

Research Question 3: What is the level of lecturers' self-efficacy in using podcasts for teaching in tertiary institutions?

Table 4: Mean and Standard Deviation on Respondents on Self-efficacy

S/N	Items	Mean	SD	Decision
1.	Install Audacity software via Internet	2.96	0.89	Agree
2.	Open Audacity software through the Icon programme file	2.88	0.83	Agree
3.	Adjust the settings using the main control panel	2.90	0.89	Agree
4.	Record, play and pause my recording material	2.86	0.88	Agree
5.	Use edits tools such as Cut, Copy, Paste, Trim, Undo, Redo, Zoom in and out	2.96	0.89	Agree
6.	Use tools Toolbar for selecting volume adjustment, zooming and time-shifting of audio	2.92	0.85	Agree
7.	Connect the microphone, select the mixer, and check the input volume and save the file as MP3	2.88	0.89	Agree
8.	Recording from CD or DVD and Internet Radio	2.84	0.86	Agree
9.	Trimming the beginnings and ends of a clip	2.83	0.89	Agree
10.	Deleting unwanted audio and Noise removal	2.76	0.85	Agree
11.	Upload (Publish) the recorded materials to the Internet	2.88	0.94	Agree
	Cumulative Mean	2.88		

Decision Mean = 2.50

Table 4 shows the perception of lecturers' self-efficacy of using podcasts for teaching in tertiary institutions in Niger State. It was observed that the respondents are in agreement in their self-efficacy of using podcasts for teaching in tertiary institutions. This is because the cumulative mean 2.88 is greater than the decision mean 2.50.

Discussion

Research question one sought to know if lecturers are aware of the use of podcasts for teaching in tertiary institutions in Niger State. The results of the study revealed that respondents agree with the questions which have highest mean response. This indicates that most respondents agree that most lecturers are aware of the use of podcasts for teaching in tertiary institutions. This is in line with Smith and Doyle 2002 who noted that new ICT tools provide a channel through which lecturers' can enrich their awareness of podcasts for teaching.

Research Question two was set to investigate perception of lecturers' readiness for the use of podcasts for teaching in tertiary institutions. It was however discovered that lecturers in higher institutions of learning are ready to embrace the use of podcasts for teaching. This corroborates the study of Tubaishat and Lansari (2011) who observed that teachers and students are ready to embrace e-learning technology, but there needed to enhance their technical capacity through training for successful e-learning adoption. Though most students accept e-learning, they lack basic computer skills required of them to effectively use e-

learning platform. Their study revealed a positive correlation between computer literacy and e-learning acceptance.

Research question three unravelled the perception of lecturers on their self-efficacy in the use of podcast for teaching in higher institution. The findings indicate that lecturers have moderate efficiency in the use of podcast for teaching in higher institutions. This finding lends credence to the work of Lakhal, Khechine and Pascot (2007) who discovered that students who listened to a lecture podcast were more satisfied and therefore learned more effectively which shows that lecturers have self-efficacy in the use of podcast. This finding is also supported by Francom, Ryan and Kariuki (2011) who observed that podcasts had a positive effect on the students' achievement as the podcast group performed better than the non-podcast group which shows high level of self-efficacy in the use of podcast.

However, it contradicts the study of Adedeji (2011) who found out that there is low level of usage of ICT gadgets and non-availability of some ICT equipment with the sluggish use and integration of ICT. In the same vein contradicts the study of Ololube, Kpolovie, Amaele, Amanchukwu, and Briggs (2013) who discovered that Nigerian students and teachers have been unable to find effective ways to use technology in the classroom and other aspects of their teaching and learning.

Conclusion

Based on the findings of the study, the following conclusion was drawn.
Lecturers in higher institutions of learning are aware of the existence of podcast and its adequacy to embellish the teaching and learning processes as a supplementary material. The level of readiness of lecturers in adopting podcasts for their various classes is remarkable as this is enshrined in their urge to integrate technological innovations in their classroom as they are capable of sustaining and influencing students' interest and academic performance respectively. Lecturers have moderate self-efficacy in the use of podcast for teaching and learning in higher institution.

Recommendations

In the light of the findings of this research, the following recommendations are made:

1. Lecturers' should be given opportunity to identify and exploit the use of podcasts in their subject curriculum.
2. Tertiary institution administrators should also help by organizing seminars to educate lecturers' on the use of podcasts to teach and should recommend Edupodcast programs for the teaching and learning in Nigeria school system.
3. The use of podcasts for teaching can be added to the methods of teaching in tertiary instructions.
4. Lecturers' should determine appropriate learning period for teaching and learning the use of podcasts that can enhance their self-efficacy on podcasts.
5. Management of various higher institutions should provide enabling environment that can help lecturers' explore e-learning platform.

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CHARACTERIZATION AND MODELING OF CONDENSATE RELEASED FROM AIR CONDITIONER

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Abstract
The study assessed the variability in the physico-chemical, microbial and metallic constituents in condensate released from air conditioner. Four sampling points were randomly selected at the Federal University of Technology Minna, GidanKwano Campus, Niger State Nigeria. The collected samples of condensate were taken to the Federal Ministry of water Resources Regional Water Quality Laboratory Minna, for analysis after which a linear regression model was used to determine the discharge rate of condensate from air conditioner. The model was also applied to estimate the volume of water that could be collected from functional air conditioner in the study area. The laboratory analyzed results were compared with NSDWQ 2007/NESREA 2011 standards for water, the results from the laboratory analysis revealed that Lead and Carbonatewere not detected in the samples, while TDS, conductivity, dissolved oxygen and pH were detected to be 11.00±3.27 mg/l, 16.50±5.32µS/cm,7.16±0.04, and 7.16±0.04mg/l respectively in the samples which falls within the desired limit of standard. Results from the laboratory analysis revealed the amount of chromium, zinc, chloride, iron, sulphate and copper in the sample as 0.03 ±0.01mg/l, 0.12 ±0.15mg/l, 3.90 ±0.66mg/l, 0.03 ±0.02mg/l 4.25 ±1.71 mg/l and 0.14±0.09mg/l respectively, which does not exceed the maximum permissive limit of the NSDWQ 2007/NESREA 2011 standard for water.The concentration of sodium, potassium, calcium, magnesium and total hardness in the sample were 1.00 ±0.00mg/l, 2.50 ±0.58mg/l, 4.30 ±0.88mg/l, 3.91 ±2.32mg/l, and 8.21±3.19mg/l respectively, which does not exceed the maximum permissive limit levels of the NSDWQ 2007/NESREA 2011 standard for water, It was established that the physico-chemical, microbial and metallic constituents of condensate released from air conditioner does not exceed the acceptable, desired and permissive limit of NSDWQ 2007/NESREA 2011 standard for water. Based on these findings, the study recommends that the water,which may not be suitable for drinking, could be used for domestic and industrial purposes such as toilet flushing, outdoor watering, cloth washing, car washing and cooling tower and not to be consumed due to insecticides and other environmental control chemicals sprayed in places, which could be sucked into the water from the air filter units of an air conditioner. A condensate collection line and tanks should be included in the plumbing design of a building to avoid stains on walls, and control the growth of fungi and other bacteria in the environment.

Keywords: Condensates, air conditioner, physico-chemical, microbial and metallic constituents

Introduction

Air conditioning and refrigeration are used around the world for temperature variation and food preservation (Boulware, 2013). In an air conditioning system, the air is being cooled

at the cooling coil through dehumidification, causing water to be removed as condensate. Meanwhile, condensation is a process which result to change in state from a gas to a liquid, and it occurs when a vapor is cooled below its saturated temperature.

Condensate generated by air conditioner can be used, however proper and safe collection of the water is required, to control the breed of bacteria such as legionella. The water could be channeled into a collection tank, or collected into a vessel that has a narrow in-let tip (a can) to minimize exposure to atmospheric or biological contaminants from the environment (Boulware, 2013).

The moisture holding capacity of air is temperature dependent. Higher temperature air can hold more water vapor than colder air. The amount of water vapor being expressed as kilogram of water per kilogram of dry air is related to the dampness of the atmosphere known as humidity. Water vapor that exist in a gaseous mixture of air is termed relative humidity expressed as percentage of the water vapor that can be suspended at that temperature. As a result of the temperature difference between the cooling space of an air conditioner and that of the outer space, a reasonable amount of condensate could be estimated with respect to time, using a mathematical model.

Reclaimed air conditioning condensate is high-quality water with low mineral and chemical content and has many potential uses, but care must be taken with its use and distribution in a fashion that would cause aerosols (e.g. lawn sprinklers) should be avoided due to the possible exposure of persons to legionella bacteria. If the use of air conditioning condensate could expos persons to inhalation of bacteria, then proper collection and purification of the water should be done prior to use (Boulware, 2013).

Since this condensate could be collected, it can be classified, analyzed and used as a supplementary source of water rather than considering it a waste, which later turns out to cause stains and breed algae on the wall and floor of a building if not controlled (Boulware, 2013).

The global demand for water is increasingly becoming high, despite all possible techniques and strategies put in place by governing body of various nations to provide amenities that will make water available and accessible to humanity, drought and water shortage is still experienced in some nations (World Water Development Report, 2003).

Though the hydrosphere is estimated to contain about 1.36 billion m^3, only about 0.3 % of the water, existing as fresh water in rivers, streams springs and aquifers, is available for human use; the remaining 99.7% (salt water) is locked up in seas and oceans (Muhammad et al., 2007).

The condensate from air conditioner could be classified as a form of surface water termed to be an artificial source of water, it is also a dehumidified air gotten from an open space through an air conditioner per time, it is the collection of water vapor in the atmosphere or air through a condensation process (Boulware, 2013).

Characterization of condensate released from air conditioning system reveal to users how usable the water could be, meanwhile modeling an equation for the discharge rate will help an individual in estimating the volume of water that could be collected from an air condition per time. With the application of the modeled equation, air condition condensate collection duct or unit (Tanks) could be included in the plumbing design of a building with all the condensate from the building collected in a single tank, and may be used for irrigating

indoor gardens, flowers, as well as being channeled to the toilet flushing system, or other domestic activities as well as industrial services such as using it in the cooling tower of a plant rather than watching it become breeding medium for algae on the wall and floor of a building resulting to stains if not controlled. The numbers of air condition in a building will determine the size of the tank to be used for the collection.

Amount of Water Required Per Day

Base on the consideration for use of condensate from air conditioning system, if a building is having a large numbers of air conditioner installed in it, and all the condensate been collected in a single condensate duct tank, the possible usage of the water could be for: toilet flushing, outdoor watering (garden), supplement for cooling tower, car washing, cloth washing and bath, (Gupter*et al.,* 2009).

The Table 1.1 below summarizes the volume of water that could be used for some activities.

Table 1.1: Volume of Water Required From Air Conditioning System

Activities	**Required Volume**
Toilet flushing	1.6 Gallons per flush (7.3 Litres)
Outdoor watering (garden)	4.4 Gallons per day (20 Litres)
Cloth washer	40 gallons per Load (181.8 Litres)
Car wash	8.8 Gallons per car (40 Litres)
Cooling Tower	Continuous channeling
Total Volume Required	17.6 Gallons (221.8 Litres)

Source: (Gupter*et al.,* 2009)

Materials and Methods

Description of the Study Area

The Federal University of Technology GidanKwano Campus (main campus) Minna, Niger State Nigeria, was selected as a case study for this research work, in which samples were collected at four different locations of the campus (Senate Building, School of Environmental Technology (SET), School of Engineering and Engineering Technology (SEET), and School of Entrepreneurship and Management Technology (SEMT).

The main campus at GidanKwano is located along Minna-Bida road about 20 km away from the Bosso Campus of the University, which is inside Minna town of Niger State (https://www.futminna.edu.ng/.../179-2017-2018-pre-admission-screening-exercise, 2018).

Minna City is both the administrative headquarters of Niger State and Chanchaga Local Government Area, she lies at latitude 90 37' North and longitude 60 33'East on a geological base of undifferentiated basement complex of mainly gnesis and migmatite (Students' Affairs Division FUTMinna Report, 2014).

Niger State of Nigeria lies between Latitudes 8^0 20'N and11^0 30'N and Longitudes 3^0 30'E and $7^0$20'E with twenty-five local government area councils, it is located in the North central part of Nigeria, sharing boundaries with Zamfara State in the North, Kebbi State and Republic of Benin in the Northwest, Kwara State in the Southwest, Kogi State in the South and Federal Capital Territory (FCT) and Kaduna State in the Southeast and Northeast, respectively (NMLH&S, 2001).

Sample Collection and Preparation

The water was collected within a period of two months (August – September) taking note of the weather temperature as related to the discharge rate, water was sampled from air conditioning system, adopting a flexible polyethylene tubing (rubber hose) to run from drain outlet securely into polyethylene (plastic) sampling keg (2 Liters) each, from four different locations of the Gidan Kwano campus (Senate Building, School of Environmental Technology (SET), School of Engineering and Engineering Technology (SEET) and School of Entrepreneurship and Management Technology (SEMT)), meanwhile the sampling keg was rinsed with the same sample before collection in compliance with the WHO, 2006 standard sample collection procedure, as gummed paper labels was used to prevent sample misidentification, samples were delivered to the Federal Ministry of Water Resources Regional Water Quality Laboratory Minna, Niger State, Nigeria, immediately after collection on the same day for analysis.

Determination of the physico-chemical, microbial and metallic parameters: All experimental /analysis was carried out at the Federal Ministry of Water Resources Regional Water Quality Laboratory Minna, Niger State, Nigeria, using standard procedures with compliance to the American Public Health Association (APHA, 2005) standard methods.

Results

Table 1.2 : Summary of Experimental (August – September) and Calculated Results Compared with NSDWQ and NESREA Standard

Parameters	Haier Thermocool	LG	Panasonic	SHARP	Average/ S.D	NSDWQ 2007/ NESREA 2011
pH	7.18	7.19	7.11	7.15	7.16±0.04	6.5-8.5
TDS (mg/L)	11	15	7	11	11.00±3.27	500
Conductivity (µS/cm)	16	23	10	17	16.50±5.32	1000
Temperature (^oC)	26.2	26.3	26.3	26.2	26.25±0.06	Ambient
Dissolved Oxygen (mg/L)	7.18	7.19	7.11	7.17	7.16±0.04	>4.0
Chloride (mg/L)	4.0	4.6	3.0	4.0	3.90±0.66	250
Sodium (mg/L)	1.0	1.0	1.0	1.0	1.00±0.00	200
Potassium (mg/L)	3.0	2.0	2.0	3.0	2.50±0.58	50
Total Hardness(mg/L)	7.42	6.05	6.44	12.92	8.21±3.19	500
Calcium (mg/L)	4.0	3.61	4.0	5.6	4.30±0.88	180
Magnesium (mg/L)	3.42	2.44	2.44	7.32	3.91±2.32	40
Zinc (mg/L)	0.06	0.03	0.04	0.34	0.12±0.15	3.0
Iron (mg/L)	0.04	0.05	0.03	0.01	0.03±0.02	0.3

Copper (mg/L)	0.17	0.16	0.22	0.01	0.14±0.09	1.0
Chromium(mg/L)	0.04	0.03	0.04	0.02	0.03±0.01	0.05
Sulphate (mg/L)	4.0	6.0	5.0	2.0	4.25±1.71	100
Lead (mg/L)	0	0	0	0	0.00±0.00	0.01
BOD (mg/L)	0	0	0	0	0.00±0.00	6.0
COD (mg/L)	0	0	0	0	0.00±0.00	30
Carbonate (mg/L)	0	0	0	0	0.00±0.00	–

Figure 1.1 represents the plot of the concentration of various parameters against the average value of parameters in samples and standard value.

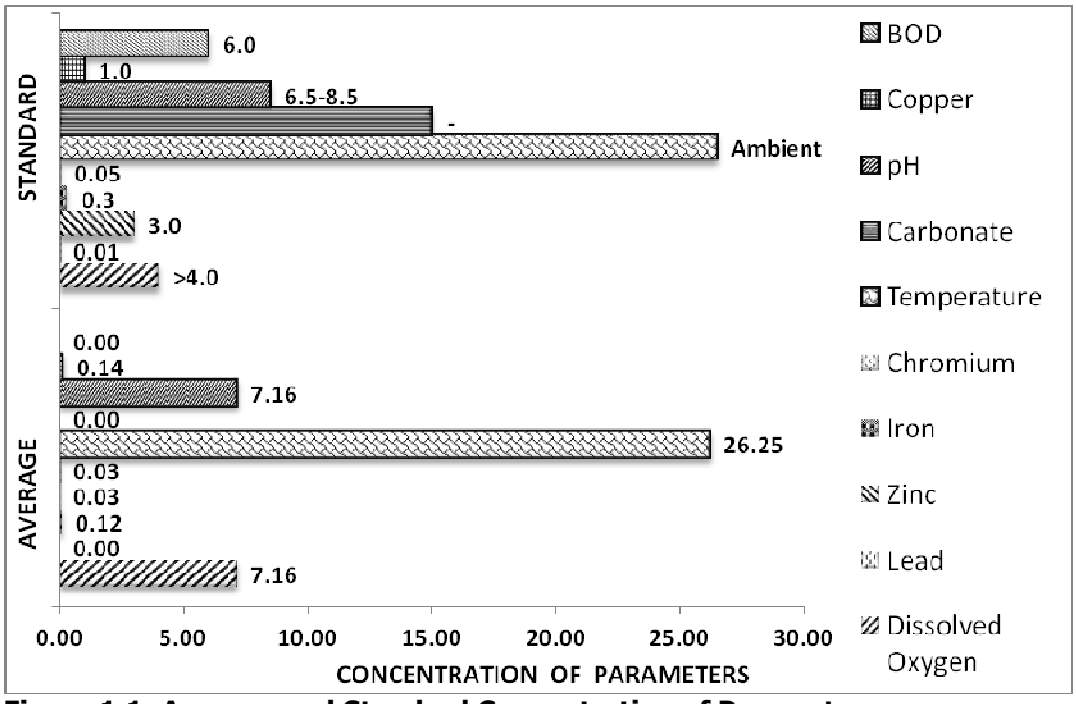

Figure 1.1: Average and Standard Concentration of Parameters

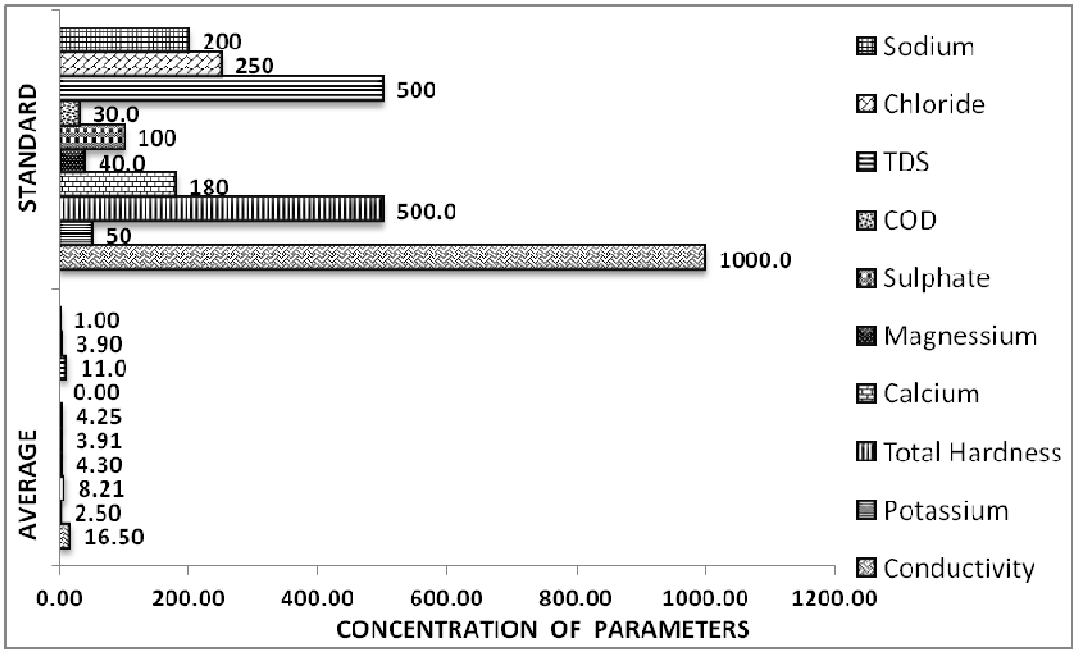

Figure 1.2: Average and Standard Concentration of Parameters

Discussion

From the results of the physico-chemical, microbial and metallic properties of air conditioner condensate in Table 1.2, It can be seen that there is no trace of Lead, BOD, COD and Carbonate with an average standard deviated value as 0.00±0.00, 0.00±0.00, 0.00±0.00, 0.00±0.00 respectively. The value of sodium seem to be identical for all products of air conditioner having a confidence limit of 1.00±0.00 and are between the desirable limit of the Nigerian Standard for Drinking Water Quality (NSDWQ, 2007).

The pH value in Table 1.2 and Figure 1.1 implies that the samples from four different products of air conditioner (Haier Thermocool, LG, Panasonic and Sharp) has a proximity pH value of 7.18, 7.19, 7.11, 7.15 respectively and a confidence limit of 7.16±0.04. This is similar to the result for Hebron bottle water (7.16±0.24) reported by Nwodo *et al.,* (2011) in the assessment of water quality in Canaanland, Ota, Southwest Nigeria, which lies on the neutral range of a pH scale and falls between 6.5-8.5 range in the desirable limit of the NSDWQ, 2007 and the NESREA, 2011 for water. This can be said to be neutral.

The temperature value of sample shown in Table 1.2 has proximity values with a confidence limit of 26.25±0.06. This is similar to the result for well water (27.80±0.45) reported by Ezeribe *et al.,* (2012) in the assessment of physico-chemical properties in well water from Dass LGA, Bauchi State, Nigeria, which falls between the desirable limits (Ambient) of NSDWQ, 2007 and NESREA, 2011 for water.

The concentration of chromium has a confidence limit of 0.03±0.01, this is similar to the result for Gwange, Mashamari and Hausari (0.00, 0.0, and 0.00) reported by Mustafa *et al.,* (2013) in the assessment of physico-chemical and bacteriological parameters from wash borehole water in Maiduguri metropolis, Borno State, Nigeria, which lies between the permissive limits (less than 0.05 mg/L) of NSDWQ, 2007 and NESREA, 2011 for water.

The result in Table 1.2 and Figure 1.2 showed that concentration of zinc in the sample analyzed is very minute with a confidence limit of 0.12±0.15 compared to the maximum permissive limits (3.0 mg/L) of NSDWQ, 2007 and NESREA, 2011, for water.

The result in Table 1.2 and Figure 1.1 showed that concentration of copper in the sample analyzed is very minute with a confidence limit of 0.14±0.09, this is similar to the result for Gwange and Bulabullin-ngarannam (0.11 and 0.05) reported by (Mustafa *et al.,* 2013) in the assessment of physic-chemical and bacteriological parameters from wash borehole water in Maiduguri metropolis, Borno State, Nigeria, compared with the maximum permissive limits (1.0 mg/L) of NSDWQ, 2007 and NESREA, 2011, for water.

The result in Table 1.2 and Figure 1.1also showed that concentration of copper in the sample analyzed is very minute with a confidence limit of 0.03±0.02, this is similar to the result for tap water and chlorinated swimming pool (0.077 and 0.074) reported by (Nwodo*et al.,* 2011) in the assessment of water quality in canaanland, Ota, Southwest Nigeria, compared with the maximum permissive limits (0.3 mg/L) of NSDWQ, 2007 and NESREA, 2011, for water.

The concentration of TDS in Table 1.2 and Figure 1.2 describes the amount of dissolved solids in condensate samples from Haier Thermocool, LG, Panasonic and Sharp air conditioner with proximity TDS value of 11, 15, 7, and 11 mg/L respectively having a confidence limit of 11.00±3.27, this is similar to the result for Hebron bottle water and rain water (15.00 and 15.00) reported by (Nwodo*et al.,* 2011) in the assessment of water quality in canaanland, Ota, Southwest Nigeria, which falls between the desirable limits of NSDWQ, 2007 and NESREA, 2011, for water.

The conductivity value in Table 1.2 of the condensate samples from air conditioner with proximity value of 16, 23, 10, 17 µS/cm respectively has a confidence limit of 16.50±5.32, this is similar to the result for rain water (16.7±2.30) reported by (Nwodo*et al.,* 2011) in the assessment of water quality in canaanland, Ota, Southwest Nigeria, which falls between the desirable limits (less than 1000 µS/cm) of NSDWQ, 2007 and NESREA, 2011 for water.

Based on the values shown on Table 1.2 and Figure 1.2, the concentration of chloride in the sample is minimal having a confidence limit of 3.90±0.66, this is similar to the result for Asho and Nkwoka-obimo spring (3.9 and 3.99 mg/l) reported by (Okechukwu*et al.,* 2012) in the assessment of parameters in spring water in Nsukka, Nigeria, compared with the maximum permissive limit (250 mg/L) of NSDWQ, 2007 and NESREA, 2011 for water.

From Table 1.2 and Figure 1.2, potassium has a confidence limit of 2.50±0.58 which lies between the desirable limits (50mg/L for potassium) of NSDWQ, 2007 and NESREA, 2011 for water.

The total hardness is a sum of the concentration of calcium and magnesium in the sample, this is summarized in Table 1.2, the total hardness has a confidence limit of 8.21±3.19 which falls between the desirable limit (500 mg/L) of the NSDWQ, 2007 and NESREA, 2011 for water.

The result in Figure 1.2also showed that sulphate is minute in sample, having a confidence limit of 4.25±1.71 which fall in the permissive level of NSDWQ, 2007 and NESREA, 2011 for water relating this to a study carried out by Kori where he stated that the higher the values obtained the higher the capability of causing bad smells or odour (Kori *et al.,* 2006).

Results of the Modeled Equation for Condensate Discharge Rate

The Table 1.3 shown below depicts the recorded time and volume of sample used in developing the linear regression model through the application of Microsoft excel 2007 software package.

Table 1.3: Recorded Time and Volume of Discharged Condensate

Time (Min)	Measured Volume of Condensate (L)	Predicted Volume of Condensate (L)
0	0	0
10	0.15	0.1677
20	0.318	0.3187
30	0.483	0.4697
40	0.63	0.6207
50	0.769	0.7717
60	0.898	0.9227
70	1.027	1.0737
80	1.199	1.2247
90	1.372	1.3757
100	1.571	1.5267
110	1.742	1.6777
120	1.899	1.8287
130	2.036	1.9797
140	2.16	2.1307
150	2.275	2.2817
160	2.381	2.4327
170	2.492	2.5837

Modeled equation: $y = 0.0151x + 0.0167$(1.1)

Regression conformity check$R^2 = 0.9972$(1.2)

Where:

y = Volumetric discharge rate of condensatefrom air conditioner

x = Discharge time derivative

R^2 Most be approximately = 1

Slope of the equation = 0.0151

Intercept of the linear equation = 0.0167

The Figure 1.3 illustrates correlation plots of predicted condensate volume against the measured condensate volume. It shows the agreement between the predicted and measured values.

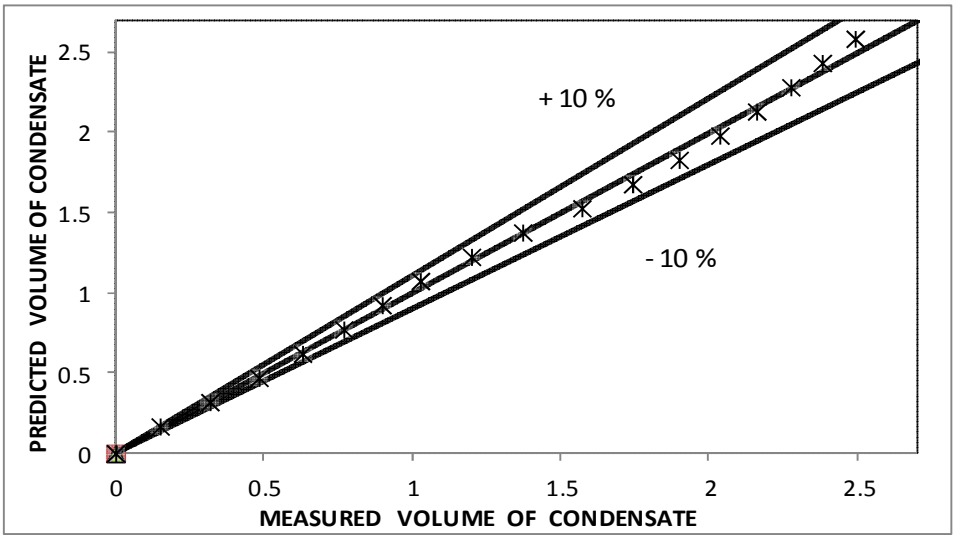

Figure 1.3: Correlation Plot of Predicted Against Measured Volume of Condensate

The modeled equation (equation 1.1) was used to estimate the amount of water that could be collected from air conditioners at various sampling location. The result in Table 1.4 was gotten as an estimate for volume of condensate from Haier Thermocool (2.2 and 1.6 Hp), LG (1.4 Hp), Panasonic (2.7 Hp) and SHARP (1.4 Hp) air conditioner. The assumptions made with regards to numbers of work days and work hours at the Federal University of Technology Minna, Gidan Kwano Campus will be explained next.

Assumptions

i. Work hour per day = 8 hours (8 am – 4 pm)
ii. Work days per week = 5
iii. Total number of Work days per year = 260 days
iv. The maximum day time temperature of Minna is about 35 ^{0}C in the months of March and April, while a minimum temperature of About 24^{0}C. The maximum day time temperature is about 35^{0}C is recorded in the months of December and January, the mean annual temperatures are between 32 ^{0}C to 33 ^{0}C, It should however be noted that the climatic conditions are subject to changes (Olasehinde *et al.,* 2014).

Required Tank Capacity $= \dot{v} \times D_n$ (1.3)

Where: $\dot{v}$ = Volumetric discharge rate per year (L / Yr)

D_n = Number of work days per month

Let D_n = 260 Days / 12 months

As 260 Days ≡ 1 year

NB : required tank capacity was rounded up to the nearest hundred.

Table 1.4: Volumetric Discharge Rate of Condensate from Air Conditioner

Location	Numbers of functional air conditioner	Litres per minute	Litres per hour	Litres per day	Litres per year	Required tank capacity/ month
Senate building	56	1.78	51.67	406.82	105,531.82	8,800 (L)
SET	49	1.56	45.21	355.97	92,340.34	7,700 (L)
Chem Engrg Department	19	0.60	17.53	138.03	35,805.44	3,000 (L)
SEMT	17	0.54	15.69	123.50	32,036.44	2,700 (L)
TOTAL	141	4.48	130.1	1,024.32	265,714.04	22,200 (L)

The result of the modeled equation shown in Table 1.4 revealed the amount of generated from an air conditioner to be 0.92 L/hr and 1,884.50 L/yr and require 200L storage capacity tank. While the amount of condensate that will be generated by functional air conditioner from the Senate building, SET, SEET (Chemical Engineering Department) and SEMT is estimated to be 105,531.82 L/yr, 92,340.34 L/yr, 35,805.44 L/yr and 32,036.44 L/yr respectively, and requires a condensate collection tanks with storage capacities of 8,800 litres for Senate building, 7,700 litres for SET, 3,000 litres for Chemical Engineering Department, and 2,700 litres for SEMT.

Conclusion

This study presented the level of physico-chemical, microbial, and metallic parameters such as, pH, TDS, conductivity, temperature, dissolved oxygen, chloride, sodium, potassium, total hardness, calcium, magnesium, zinc, iron, copper, chromium, sulphate, lead, BOD, COD and carbonated in the condensate discharged from air conditioning system at the Federal University of Technology Minna, Gidan Kwano campus, Niger State Nigeria.

The result shows that all the parameters analyzed does not exceed the permissive limit of NSDWQ, 2007 and NESREA, 2011 standards and a such the water could be used for domestic and industrial purposes such as toilet flushing, outdoor watering, cloth washing, car washing and cooling tower.

The modeled equation gave an approximate volume of water discharged per unit time from an air conditioner when compared with the experimental sampling time recorded at ambient temperature.

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