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The Influence of Students' Concept of Mole, Problem Representation Ability and Mathematical Ability on Stoichiometry Problem Solving

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Abstract:

Students' success in stoichiometry problem solving depends mainly on their understanding of the concept of mole and conceptual understanding of the problems. The challenge of enhancing students' performance in solving stoichiometry problems remain a daunting task as many resort to just teaching how solve stoichiometry problems algorithmically. Two purposes of this study are: first, identifying the major factors influencing students' performance in stoichiometry problem solving and second, investigating problems faced by students and teachers in stoichiometry learning and teaching in the classroom. A mixed method research design was employed in this study which

involved a test and interview protocols. To conclude, students' understanding of the concept of mole and their problem representation ability are significant predictors, however mathematical ability is not a significant factor in determining students' success in solving the problems. Students have difficulties in 'making sense' of the chemical reaction itself. This implies teachers should not practice the 'short cut' approach in the entirety. Students ought to be exposed and guided to understand the underlying conceptual foundation of stoichiometry before introducing the algorithmic way of solving the problems.

Keywords: stoichiometry problem solving; mole concept; problem representation ability; mathematical ability.

Introduction

Stoichiometry is an important part of many practicing chemist's work. It is a topic in chemistry that calculates the quantity of a product that can be obtained from a reaction by assuming that the reaction is the only one involved and that the entire product is collected (O. Daley Jr. & O'Malley, 1988). It cuts across many sub disciplines of chemistry such as analytical chemistry, physical chemistry and organic chemistry. Hence, the instruction of stoichiometry problem solving is considered an essential part of the curriculum for chemistry students.

Students who do not fully understand the mole experience difficulties in understanding the subsequent topics (Musa, 2009). Especially, in stoichiometry problems since the calculations revolve around the mole concept. Stoichiometry calculations have been considered difficult by students in general chemistry (Hanson & Wolfskill, 1998). This is due to the many different facets a student must master, such as the mole concept, balancing chemical equations, algebraic procedures, and interpretation of a word problem into mathematical equations that serve as procedural steps which would then lead to the correct answer. Case and Fraser (1999) has shown that students have acute difficulties in dealing with the abstract concepts required of them to perform stoichiometric calculations using the mole concept. They also found that for students to solve stoichiometric problems, they must also be able to apply a thorough understanding of the principles involved in mole ratio and proportion calculations.

From the literature, one of the most commonly used tools to solve stoichiometry problems is dimensional analysis (To'th dan Sebestyén, 2009). This method involves analysis of mole, molarity, volume or mass of reactants. However, there are several other methods designed and developed over the years to help students overcome the difficulties solving these types of chemistry problems (Poole, 1989; Krieger, 1997). Proportional reasoning method and the mole ratio flow chart method (both involve mole ratio understanding) are also among the most known methods employed to solve stoichiometry problems (Wagner, 2001). While all of these methods have been useful in the author's classroom, none seemed to offer meaningful ways for helping students to really understand reaction stoichiometry calculations.

To improve the problem solving skills of students, it seemed that instructors must first focus on developing students' knowledge base and skills base. Without these, students could not succeed in true problem solving. Heavy emphasis should be placed first on conceptual understanding of topics; then maybe the secondary emphasis should be placed on carrying out and completing drills and exercises.

Literature review

Stoichiometry teaching

The literature indicates quite a number of studies investigated effective teaching strategies for the topic (Gabel & Sherwood, 1984; Bunce, Gabel & Samuel, 1991; Case & Fraser, 1999). However, these studies seemed to focus on algorithmic methods in solving stoichiometry problems.

Davidowitz, Chittleborough and Murray (2010) insisted submicro diagrams being used as tools for reasoning in solving chemical problems, in teaching chemical equations and stoichiometry.

Gauchon and Méheut (2007) studied the impact of teaching stoichiometry on students' conceptions. They have the conception both reactants are totally converted is quite strong in those problems where reactants are in the same physical state, and is more in competition with the conception: only one reactant is totally converted when the reactants are in a different physical state.

Gabel and Sherwood (1984) reported that the 'factor label' method (matrix) is the most effective method, whereas the 'proportional' method (mole ratio) is the least effective. On the other hand, Wagner (2001) found that there was no statistically significant difference in students' performance on reaction stoichiometry between the DA (dimensional analysis teaching method) group and the MRFC (mole ratio flow chart method) group. Only one study reported that the use of tangible objects and thoughts experiments did have an impact on students' conceptual understanding on the subject (Case & Fraser, 1999).

Ashmore, Frazer, & Casey, (1979) proposed a model of problem solving that involves four stages. Identifying the problem is the first stage in the model. At this stage, students are expected to restructure a given problem into smaller problem statement. Next, is to select relevant information from memory. Here, students are expected to relate the information given with the question. Then, the third stage, students need to use the relevant information, to solve the problem. To this end, students are required to perform mathematical operations or deductive reasoning.

Students' difficulties with stoichiometry

Many studies show that students have trouble understanding the concept of the mole, concentration, molar mass, the mass of material, chemical equations and the limiting reagent (Frazer & Servant, 1987; Lythcott, 1990; Schmidt, 1990; Heyworth, 1999; Chiu, 2001; Meor Ibrahim, Ambrose, & Ling, 2003; Dahsah & Coll, 2007; Noraihan, 2008). In an investigation involving French grade 10 students, Laugier and Dumon (1990) (cited in Huddle & Pillay, 1996) analysed students' answers during a teaching sequence concerning reactions between two solutions: sodium hydroxide and copper sulphate. They reported that 88% of the students thought that there are neither copper ions nor hydroxide ions left at the end. For these students, all the ions have reacted; they did not envisage a possible surplus of a reactant in such a case. Another study using questionnaires about limiting reactants (Gauchon 1992, also cited in Huddle & Pillay, 1996), found that 68% of the students (grade 10 or later) said that the reaction between chalk and hydrochloric acid solution stops when there is no more chalk, whatever the quantities of chalk and hydrochloric acid. So, it seems that when beginning to learn about chemical reactions, students explain and interpret the final state of a chemical change in different ways, depending on experimental situations.

A case study conducted by Meor Ibrahim, Ambrose, and Ling (2003) on 18 students of Chemical Education Degree, reviewing student achievement on mole concept and the concept of matter and its effect on problem solving ability stoichiometric. The results showed that only 22% of the students understand chemistry concepts which is 6% to the concept of atoms, 6% are able to understand the concept of molecules, and 11% understand ion with the right concept. For the mole concept and its relationship to the equation, the achievement of conceptual understanding of the respondents was very poor.

Dahsah and Coll (2007) reviewed the achievements of 97 students from three secondary schools in Bangkok, Thailand, through questionnaires. Their study found that only 2% of the total respondents were able to understand all of the concepts tested on the chemical formula, chemical equations, the mole, molarity of solution, the limiting reagent, and the mass of the reactants. It is supported by the findings obtained by Noraihan (2008) in which a study was conducted on 70 form four students in three schools in the district of Mersing. The study which also used questionnaires

showed that students experience difficulties in solving problems related to mole concept because they cannot relate the mole to the number of particles, the mass of substance and chemical equations.

Problems with mole ratios

Case and Fraser (1999) underlined another level of understanding among first year university students. They noted that students can be inclined to use a ratio equal to one between the amounts of matter of reactants whatever the transformations. It seems that these students have developed some idea of proportion between reactants but they can't consider any other ratio but one. Is this only due to the incapacity to use another ratio or is this linked with previous conceptions about chemical changes? These examples suggest different levels of understanding of stoichiometry. It seems that this notion needs to be built step by step, probably against strongly established conceptions.

In another study, Laugier and Dumon (1990) (cited in Huddle & Pillay, 1996) implied that when students feel the need to take into account proportions in a chemical change, some difficulties may appear. Spontaneously, they think of 'appropriate' volumes or 'appropriate' masses. They failed to understand that the quantities to be taken into account are amounts of matter that implies the use of the mole concept. Another group of researchers, Case and Fraser (1999) also noted that even among first year university students, a lot of mistakes in problem solving are due to confusion between different chemical quantities. Concentration, mass or volume is often used instead of the amount of matter. In another study, Dahsah and Coll (2007) show that students have an alternative framework that related to the mole ratio of the mass ratio, the limiting reagent as the reactant with the smallest quantity in the form of mass and not the mole, and are using mol ratio of 1: 1 for all reactants.

Stoichiometry and balancing equations

In a study, Yaroch (1985) noted that 27% of students succeeded in solving stoichiometric problems, and 22% (of the total) interpreted and correctly used balanced equations, inferring that successfully writing a balanced equation and in interpreting correctly stoichiometric coefficients provides the basis of success in solving problems.

Niaz and Lawson (1985) reported students' difficulties in correctly interpreting a balanced equation. The different representational levels included in a balanced equation are very difficult to distinguish for students. For example, in the multiple choice tests given to them, the grade 10 students found it hard to understand that just one script, the balanced equation, can represent many experimental situations. Thus, at the end of a chemical change, students were surprised to find compounds that did not appear in the right hand side of the balanced equation. The authors also warned teachers that some students consider that chemical equations implied the use of stoichiometric quantities of reactants only. Moreover, they stressed that balanced equations may make students interpreted the chemical equation at a microscopic level only.

Mathematical ability in stoichiometry

Wink et al. (2000) conducted the MATCH program. It was a preparatory chemistry and intermediate algebra curriculum. They used integrated curriculum and text that include core material for standard preparatory chemistry and key algebra topics. The program revealed several advantages of an integrated curriculum. One example involves the benefits of developing unit conversion or dimensional analysis methods by discussing their roots in direct variation. Direct variation, $y \propto x$, means that we can relate two variables by the equation $y = kx$. The 'k' is referred to by mathematicians as a constant of proportionality, but by chemists as a conversion factor. Such factors are commonly used in molar mass, Avogadro's number, etc. Approaching diverse problems from a simple basis in mathematics seemed to render instructions more efficient and students more adept at transferring calculation skills. In this manner, many of the calculations involved in stoichiometry problems are given a common conceptual basis, an important ingredient if we want students to

transcend algorithmic problem-solving with a qualitative understanding. The explicit link between mathematics and chemistry in the MATCH program seemed to produce the desired outcome. When MATCH students later took chemistry courses they did better than their colleagues who took the conventional preparatory chemistry course.

[Schmidt](#) and [Jignéus](#) (2003) employed semi structured interview in their research and found that students used a non-mathematical strategy to solve an easy question. However, in moving from an easy-to-calculate problem to a more difficult one most students calculated the mass fraction or the percentages of an element in a compound. In this form the strategy comes close to the non-mathematical strategy. It is suggested for introductory chemistry courses to use easy-to-calculate problems and to concentrate on both the non-mathematical and the mass fraction strategy.

Surprisingly, despite the belief that mathematical ability has a strong influence on students' ability in stoichiometry problem solving, not many studies could really prove this. Nevertheless, the present study intends to explore the relationship between the two variables, focusing on students' algebraic mathematical ability and their effect on the performance of stoichiometric problem solving.

Problem Representation Ability

Experts are better problem solvers because they construct richer, more integrated mental representation of problems than do novices (Chi & Bassock, 1991). It is believed that problem solvers need to construct some sort of internal representation (mental model) of a problem in order to solve it. This personal problem representations serve to guide further interpretation of information about the problem, simulate the behaviour of the system based on the knowledge about the properties of the system, and triggering a particular solution schema (procedure) (Jonassen, 2003). Bodner and McMillen (1986) believed that students must disembed relevant information from a question and restructure the problem. 'Restructure' here means the modification of objects, operators, constraints as well as the initial and final states. This belief seemed to be true in solving stoichiometry problems. Researchers (Staver & Jacks, 1988; BouJouce & Barakat, 2000) indicated that students must be able to translate the worded problem of a stoichiometry problem into a balanced chemical equation and then use the appropriate mathematical equation, before solving the problem. In one study, Schwartz (1971) found that 'matrix representation' (a method to represent chemistry problem by dissecting the information given in columns or boxes) has the most significant effect on internal problem representations. It was substantially superior to grouping, graphs, and sentences because they allow for clearly defined needed information, suggest orders of operations, and provide consistent checks for partial solutions to be seen. Schwartz's finding was consistent with Gabel and Sherwood's work on the 'factor label' (matrix) method, which revealed that students engaging the matrix method showed better performance than the control group in solving stoichiometry problems.

In short, teachers may present qualitative problems in many forms and organizations. Nevertheless, it is important to note that qualitative representations support the solution of quantitative problems. Successful chemical problem solving requires both qualitative and quantitative reasoning (Ploetzner & Spada, 1998). Hence, training students to recognize and qualitatively represent problems could improve students' problem-solving performances.

The purpose of this study was two-pronged in nature. First, it attempted at identifying the major factors influencing students' performance in stoichiometry problem solving. By doing so, this study also tried to determine whether the major factors identified by the researcher constituted a solid ground for stoichiometry teaching. Second, the present study aimed at probing problems faced by students and teachers in stoichiometry learning and teaching in the classroom.

Methods

The study employed a mixed method design. It engaged both quantitative and qualitative approaches. The quantitative part of the study was designed to measure how students' performance

in stoichiometry problem solving (PS) was affected by the three variables; understanding of the concept of mole (C), problem representation ability (PR), and mathematical ability (MA). A self-constructed written test comprised of 14 items (validated by an expert chemistry teacher and a chemistry lecturer from a local university) was the instrument employed to conduct the stepwise MRA to analyse the contributions of the three variables on PS and to seek out the best predictor.

This study also employs the interviewing methods to address the qualitative research questions. A set of written interview questions, a verbal interview and a think-aloud interview were constructed (validated by two experts from two local universities) to address the qualitative aspects of the research questions. These structured and semi-structured interviews were designed to elicit specific answers from the respondents. The written interview was constructed to gauge students' views on stoichiometry problem solving and the verbal interview was constructed to probe the teachers' views on the subject. The think-aloud interview however, was designed to probe students' conceptual understanding of the problems and it also served to identify the algorithmic and conceptual problem solvers.

The population of the study comprised five classes of Form Four science students of an urban secondary school in Selangor, Malaysia. The school had five pure science classes with a total of 212 students. Form Four students were selected as respondents because the topic of stoichiometry was taught in the second semester of that academic year. Form Four students were also selected because they were non-examination class. This means easier access to the students and less disruptions to the school schedules and time-table. The gender ratio of the population is almost 1 to 1 with the actual ratio of male to female being 113:99 or 1.14:1. This serves as an advantage to the research as it can reduce the 'gender effect' on the results. Since the researcher also taught all the five classes herself, it is also hoped to eliminate the 'teacher effect' on the results.

Stevens (1996) suggested, in MRA, if the probability of making the correct predictions (p_2) is set at 0.50, loss of predictive power tolerated at 0.05 (C) and power at 0.80, it is estimated that $n = 36$ per predictor for a study that involves three predictors. That means the minimum number of respondents should be 108 for three predictors. Thus, the researcher included 108 respondents in the study; i.e. by using the systematic random sampling method, by ticking every second student from all the five class registers.

Ten students were randomly selected from the 108 students as respondents for the written subjective questions and think-aloud interview. These ten students were selected by randomly selecting two students from each of the five classes. All five chemistry teachers from the school were interviewed for their perceptions on stoichiometry problem solving. The subjective test was designed to test students' understanding of the concept of mole, students' ability on problem representation, their algebraic mathematical ability and the students' overall performance on stoichiometric problem solving.

Prior to constructing the test, an in-depth study on the variables involved in the study was done to estimate content validity of the test. The test was then validated by an expert teacher from a renowned smart school in Selangor and validated again by two experts from local universities. The reliability of the subjective tests was estimated by engaging the tests of correlation coefficient of the Spearman rho ($r = 0.918$). This was done by appointing two distinguished examiners (experienced chemistry teachers) to score the pilot tests according to the marking scheme and then the researcher correlates between the two examiners.

The think-aloud interview comprises three stoichiometry problems. Respondents were requested to solve the three problems aloud and while doing so, the researcher was able to probe their understanding of the concept of mole, their conceptual understanding of the problems and difficulties encountered while solving them. The reliability of the instruments was estimated by taking every possible precaution against biases and 'over interpretation' of data. Students were

asked not to write their names on the paper. This was done as the researcher taught all the respondents herself. When interviewing the teachers, the researcher made sure it was done formally, in a secluded area where the researcher and the interviewee would not be disturbed. In the think-aloud interview, one or two other chemistry teachers were also present and taking down notes during the interview. Thus, the researcher was able to confirm with the other teachers of what has been written in her notes and clarify things that were not very clear to the researcher. This method of triangulation has been adopted to control biases and establishing valid propositions or evaluation of the findings (Patton, 2001).

A pilot study was conducted prior to the test to identify problems that might arise from the instrument. Two pilot tests were carried out on 10 students to identify mistakes in the questions and to eliminate any items that may confuse the respondents. Specifically, it was intended to further evaluate the clarity of the instrument from the respondents' perspectives in terms of items construction and face validity. In addition, the pilot study allowed the researcher to identify the construct validity and the internal consistency of the instrument.

The subjective test was administered by the researcher with some help from four chemistry teachers of the same school. Arrangement was made with the other chemistry teachers so that all respondents of the five classes could sit for the test simultaneously to reduce missing respondents. Students were already told the goals of the research and participation was voluntary. It was made clear that confidentiality of responses was respected and participation or lack of participation will not influence their grades in the final school examinations.

The written interview questions were given right after the test. Ten randomly selected students from the five classes were requested to go to the chemistry laboratory after the subjective test to answer the questions. Again, here the researcher reminded all respondents, they were not required to write their names on the paper, that participation is voluntary, and they were free to go if they did not want to answer the written interview questions. None of them seemed anxious to go so the researcher proceeded with the written interview. All of the ten students answered the interview questions simultaneously. Since some of them answered the question very briefly, the researcher also gently probed and encouraged the respondents to be more elaborate in their answers.

The verbal interview on the five teachers however, was carried out at the respective schools of the teachers. While setting the date for the interview, the researcher informally asked for their consent to participate in the study and informed them that the confidentiality of their responses would be respected. The teachers were then engaged in formal interviews at their respective schools after school hours. The researcher made some arrangements to have the interview in a secluded area where she, her assistant (another chemistry teacher) and the interviewee would not be disturbed. The researcher was the sole interviewer but both she and the other chemistry teacher took down notes during the interview for the purpose of triangulation of data. To eliminate the probability of mistaken auditability, sometimes the researcher showed her notes to the interviewee to check the transcriptions and to determine the accuracy of the responses recorded.

The think-aloud interviews of the students were carried out in the chemistry laboratory of the schools after the school hours. Ten randomly selected students (with at least 2 students from each class) were selected for the interview. One or two other chemistry teachers were also present during the interviews. Again, the same method of triangulation was employed here. The two chemistry teachers acted as the researcher's assistants by taking down notes during the interview. Sometimes the researcher showed her notes to the interviewee to check whether she had heard and written the correct responses.

The students were given three stoichiometry questions to answer. During the problem solving exercise the respondents were requested to explain what they were doing. The researcher used the probing questions to encourage the students to say out whatever they were thinking, what

went in their minds when they were solving the problems. Since the researcher hoped that the respondents would elaborate their answers, the interview was done in a relaxed atmosphere and the interviews were started with some general questions. Sometimes when the students seemed quiet or at a loss on what to do, they were prompted with some remarks or questions. Based on the predetermined probing questions, the interview was casually led to the research questions and the researcher just took notes discreetly and did not use any tape recorder to minimise any uncomfortable feelings that may arise from the unusually long conversation. After that the researcher carried out triangulation with the other two chemistry teachers.

Results and Discussion

All the variables, understanding of the concept of mole (C), problem representation ability (PR), mathematical ability (MA) and students' performance in stoichiometry problem solving (PS) were analysed to determine the strength of the predictors' ability in explaining the variations in students' performance in stoichiometry problem solving (the criterion).

Table 1 shows the summary of correlations between predictors and the criterion, and among the predictors selected. An inspection of the table indicated that students' performance in stoichiometry problem solving (PS) is highly positively correlated with their understanding of the concept of mole (C) ($r = .782$), problem representation ability (PR) ($r = .897$) and mathematical ability (MA) ($r = .743$). However the Model Summary, that is presented to highlight the practical importance of the model, suggested that 84.1% of the variance was explained only by two predictors, namely C and PR. MA was then removed from the model. The high value of R square (0.841) supported the overall fit of the model. The value of R square here indicates it is a strong model.

Table 1

Inter-Variable Correlation, Means and Standard Deviations for predictors and criterion (4 variables)

	PS	C	PR	MA
Pearson Correlation PS	1.000	0.782	0.897	0.743
C	0.782	1.000	0.726	0.809
PR	0.897	0.726	1.000	0.733
MA	0.743	0.809	0.733	1.000
<u>M</u>	2.01	5.57	2.36	4.96
<u>SD</u>	2.257	2.996	2.708	2.665

*Statistically significant at $\alpha = .05$ *C - understanding of the concept of mole

*N = 108

PR - problem representation ability

MA - mathematical ability

PS - students' performance in stoichiometry problem solving

Table 2

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.897	0.805	0.803	1.003
2	0.917	0.841	0.836	0.914

*Predictors: Model 1 (Constant), PR

*Predictors: Model 2 (Constant), PR, C

*Dependent Variable: PS

Next, in Stepwise MRA, the results of the Analysis of Variance (ANOVA) would give us the ‘overall fit’ between the predictors and the criterion. The results (see Table 3), indicated that the overall strength of the relationship between the predictors and the criterion was statistically significant [$F(3,104) = 182.792, p = 0.000, MSE = 0.835$].

Table 3

ANOVA

Model	Sum of Squares	df	Mean Square	F	Sig.
1 Regression	458.110		152.703	182.792	0.000
Residual	86.881	104	0.835		
Total	544.991	107			

The results of the predictive strength of each predictor on the criterion are summarized in Table 4. PS was found to be significantly predicted by only two of the three predictors; C (Beta = .275, $t = 4.853, p = .000$), and PR (Beta = .697, $t = 12.285, p = .000$). Mathematical ability (MA) was excluded from the model since the analysis yielded an insignificant correlation to PS with the Beta value at 0.029. The results showed Beta values which indicated that PR is the strongest predictor of PS followed by C. The predicted equation for this model could be written as:

$$PS = -0.518 + 0.207C + 0.581PR$$

Where:

PS - Students’ performance in stoichiometry problem solving

C - Students’ understanding of the mole concept

PR - Students’ problem representation ability

Table 4

Regression Coefficients, Confidence Intervals and Collinearity Statistics for the Predictors of Students’ Performance in Stoichiometry Problem Solving

Model	Unstandardized		Standardized		Collinearity Statistics		
	Coefficients		Beta	t	Sig.		
	B	Std.Error				Tolerance	VIF
1 (Constant)	-0.518	0.196		-2.649	0.009		
C	0.207	0.043	0.275	4.853	0.000	0.472	2.117
PR	0.581	0.047	0.697	12.285	0.000	0.472	2.117

*Statistically significant at $\alpha = .05$

The regression coefficient of each variable gives an account of the increase in the criterion if a particular independent variable increases by a unit when the other independent variables are held constant. For instance, one unit increase of PR would generate an increase of 0.581 unit of PS when C and MA are held constant.

Table 4 above also shows that the effects of multicollinearity on the analysis were not serious. The values of Tolerance and Variance Inflation Factors (VIF) suggested that the relationships among the predictors were not significant. This result was consistent with the literature which suggested that mathematical ability was not actually a 'popular' factor that would influence students' performance in stoichiometry problem solving. Only two studies suggested the worth of this factor (BouJaoude & Barakat, 2000; Wink et. al., 2000).

To get an alternative perspective on the MRA and in an attempt to get a clearer 'picture' and to determine whether mathematical ability (MA) could really be 'dropped' from the regression equation, individual relationships were then determined between:

- (i) students' with adequate and inadequate understanding of the concept of mole (C) with their performance in solving stoichiometry problems,
- (ii) students' with high and low problem representation ability (PR) with their performance in solving stoichiometry problems,
- (iii) students' with high and low mathematical ability (MA) with their performance in solving stoichiometry problems,

Using the t-test to compare the performance of students in the stoichiometry test, produce some interesting results. All the results (Tables 5 to 10), were significant:

- (i) Students with adequate understanding of the concept of mole (HIGHC) performed better (mean = 3.97) than those with inadequate understanding (LOWC) (mean = 0.67) in the stoichiometry problem solving test.
- (ii) Students with high problem representation ability (HIGHPR) performed better (mean = 4.82) than those with lower ability (LOWPR) (mean = 0.73) in the stoichiometry problem solving test.
- (iii) Students with high mathematical ability (HIGHMA) performed better (mean = 3.23) than those with lower mathematical ability (LOWMA) (mean = 0.48) in the stoichiometry problem solving test.

The regression results seemed to significantly support only the two variables (C and PR) but do not give a significant correlation with MA. The t-test results however, seemed to support that students' mathematical ability also has a significant positive correlation with their performance in stoichiometry problem solving.

Table 5

Group Statistics for C and PS

C	N	Mean of PS	Std. Deviation	Std. Error Mean
HIGHC	39	3.970	1.633	2.069
LOWC	69	0.666	1.653	1.198

Table 6

Independent Samples Test for PS between HIGHC and LOWC

	t-test for Equality of Means				
	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Equal Variances Assumed	7.810	104.000	0.000	2.457	0.248

Table 7

Group Statistics for MA and PS

MA	N	Mean of PS	Std. Deviation	Std. Error Mean
HIGHMA	60	3.233	2.295	0.296
LOWMA	48	0.479	0.825	0.119

Table 8

Independent Samples Test for PS between HIGHMA and LOWMA

	t-test for Equality of Means				
	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Equal Variances Assumed	7.910	106.000	0.000	2.754	0.348

Table 9

Group Statistics for PR and PS

MA	N	Mean of PS	Std. Deviation	Std. Error Mean
HIGHPR	38	4.820	1.346	0.296
LOWPR	80	0.730	0.976	0.119

Table 10

Independent Samples Test for PS between HIGHPR and LOWPR

	t-test for Equality of Means				
	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Equal Variances Assumed	7.902	109.000	0.000	2.198	0.218

The Multiple Regression analysis seemed to indicate that mathematical ability is not a worthy variable to be included in the regression, and the t-test is not a 'strong' indicator that could be used to support the initial regression model, the second model of the regression which only includes the two predictors from the first MR analysis were retained. Therefore, the regression model would be maintained:

$PS = - 0.518 + 0.207C + 0.581PR$, where:

PS - students' performance in stoichiometry problem solving

C - students' understanding of the concept of mole

PR - students' problem representation ability

Qualitative Analysis of Interviews

A. Analysis of Teachers' Perceptions

The respondents of the interview were three senior teachers with more than 9 years of teaching experiences and 2 novice teachers with less than 2 years experiences. The analysis is summarized as below:

1. Importance of the understanding on the topic of stoichiometry for chemistry students

Two teachers (Teacher 3 and 4) admitted that they had underemphasized the stoichiometric topic in their teaching. Their teaching of the topic rarely probed students understanding of the underlying chemical concepts that is prerequisite in order for the students to solve stoichiometric problems very well. "Maybe I'm partly responsible for that, I didn't really emphasize the topic when I was teaching. I simply breezed through the topic as I thought that the topic is quite easy" (Teacher 3).

One interesting observation is the novice teachers (Teacher 2 and 5) seemed to be more interested in probing students' understanding in the topic. This is quite understandable since these novice teachers had just graduated from their training colleges and still have the drive to practice what they had just learned. Senior teachers (Teacher 1, 2 and 4) appeared to be more concerned with finishing the syllabus as soon as possible, so that they would have ample time to do a lot of drilling to prepare students for their examinations. With only four periods a week (approximately 140 minutes per week), teachers find themselves pressured to cover all the content of the subject as quickly as possible. Some extra periods are geared towards doing more practice and exercises with the aim of maintaining the school's performance in the SPM examination. Most senior teachers (teacher 1 and 4) seemed to be very complacent in their 'comfort zone' and think that their expertise in the subject is already adequate to build a solid understanding of the subject.

2. Teachers' difficulties in teaching the stoichiometry topic

Another interesting finding from this interview is that a greater number of teachers (Teacher 1, 2 and 4) do not perceive that teaching the stoichiometry topic to their students as a hard thing to do. Teachers were literally confused as to why students did not do well in solving stoichiometry problems. They posited that maybe their negligence to highlight the importance of the topic to their chemistry students, may contribute partly to their students performance in stoichiometry problem solving. Teacher 1, 2 and 4 however, claimed that the topic was 'easy' to teach and all teachers interviewed engaged the algorithmic approach to the topic by introducing the $\frac{MaVa}{MbVb} = \frac{a}{b}$ formula right from the beginning of the lesson of the topic. This feeling might stem from the fact that Teacher 1 and 2 came from schools with selected or better ability students. Thus, they perceived that teaching the stoichiometry was 'easy'.

On the other hand, Teachers 3 and 5 did not feel that it was an easy thing to teach the topic to students. They asserted that there were a lot of things to be taken into consideration before students can attempt to solve the problems. They also believe that they should prepare students with adequate understanding of the concept of mole, the knowledge of writing the correct chemical formula and balancing the chemical equation, before giving the students stoichiometry problems.

3. How teachers normally introduce the topic

Senior teachers did not bother with introductions. They normally start their lesson on the topic with an example of an easy stoichiometry problem. They would show all the necessary steps to solve the problem and give the students a few examples. Later, the teachers would increase the degree of difficulties of the problems and discuss the answers with the students. Senior teachers seemed to prefer the algorithmic approach to introduce the topic due to the very limited time allocated to chemistry in the school time-table.

Novice teachers prefer to 'play around' first with the calculations on mole, writing chemical formula and balancing chemical equations, before introducing the topic to their students. Then only they would give examples on the stoichiometry problems and ways to solve them. Nevertheless, novice teachers also seemed to share the same opinion with the senior teachers that the algorithmic approach was perhaps the easiest way to teach the topic.

4. Major difficulties faced by students when solving stoichiometry problems

Three teachers (Teachers 1, 4 and 5) hinted that students did not seem to understand the significance of the coefficients in a chemical equation. "Many students just apply the trial and error approach, they would try different sets of numbers, use the formula until the answer seems right" (Teacher 1). "They do not know the importance of the coefficients in the chemical equation given in the question; many do not even know how to balance a chemical equation" (Teacher 4). "Some students do not understand the values of a and b in the formula" (Teacher 5). Teacher 4 also seemed to think that a lot of students cannot determine the 'limiting reagent' in a given problem, when one substance is added in excess. "Some students seemed to think that the reagent with the lowest coefficients in the chemical equation is the limiting reagent. However, they could not explained it when there are more than one reagent have the same lowest coefficient value". This problem is related to the significance of the coefficients in a chemical reaction.

Other teachers (Teachers 1, 2 and 3) observed that students might be confused or did not know the definitions of and relationships between stoichiometric entities in general. Misunderstanding or inadequate understanding of the concepts that sounds phonetically similar such as mole, molecule, molarity, molar mass, etc, seemed to hamper students' performance in stoichiometry problem solving. "They sound almost the same, mole, molecule, molarity...no wonder students are so confused" (teacher 2). These similarly sounded chemical concepts were all introduced to chemistry students at the beginning of the Form Four year. Even though teachers were aware of the significance of students' understanding of these concepts, due to the time constraints, teachers normally just rushed through them in their chemistry lessons.

The particulate nature of chemistry may also make it confusing for students to determine the mole of substances. To calculate the mole of a substance in atomic state is quite different from a substance of molecular state. "...to calculate the mole of sulphuric acid, they need to use the volume and molarity of the acid, but to calculate the mole of copper(II) oxide used, they must divide the mass by the molar mass of the substance....students do not understand this" (teacher 1). This misunderstanding may arise from students' inability to comprehend that chemicals in different physical state may also be different in their particulate nature. Students may find it difficult to understand that substances may exist in atoms, molecules and ions. This problem could be minimized if teachers presented the lessons in a more concrete approach. Instead of using the 'chalk and talk' method, which is sometimes very confusing to the students, teachers may use the 3-D illustration of the concepts. The lack of teachers' initiative to allocate more time in providing this solid grid of understanding the chemical concepts may result in more misunderstandings or misconceptions.

In short, teachers seemed to think that determining the correct mole ratio of reactants and products, and calculating the mole of the respective chemical substances are the two major difficulties faced by students when solving the problems.

5. Factors that might contribute to students' success in solving stoichiometry problems

All teachers conceded that students' ability of problem representation is a very important factor that influences students' performance in stoichiometric problem solving. The first step a student would have to take is to translate the worded problem into a balanced chemical equation, and then transferring all information given in the question into a suitable mathematical equation. If a student failed to do this, he/she would not be able to proceed. "...students must be able to write the correct mathematical equation from the original question given" (Teacher 1). "If they could not identify the correct values of molarity, volume or mass of the substances, they may not be able to calculate and use the formula correctly." (Teacher 2) Besides representing the worded problem into a mathematical equation, they must also understand what each symbol in the equation means; otherwise they would plug in the wrong numbers into the symbols. In the $M_a V_a / M_b V_b = a/b$ formula, the M symbol is sometimes mistakenly understood as the mole or the mass of substances. Students must be able to determine the correct values of molarity, volume, mass, etc., from the question and also use them in the correct units. In stoichiometry problem solving, using the correct units for the different entities is crucial. For instance, students must be aware if the concentration of solutions given in the question is based in gdm^{-3} or mol dm^{-3} . If the concentration is given in gdm^{-3} , then they must first convert it into mol dm^{-3} before using the $M_a V_a / M_b V_b = a/b$ formula.

6. The effect of students' understanding of the concept of mole on their performance in stoichiometry problem solving

Most teachers agreed that students need to be well versed with the particulate nature of substance in order to be able to calculate the respective entities. Strangely however, some teachers (Teachers 3, 4 and 5) did not perceive that the understanding of the mole concept particularly, is essential for the students to solve stoichiometry problems successfully. Teacher 5 says; "...no, I just don't think that a student needs to understand the mole concept very well in order to solve it, they must know the mole concept in order to be able to know how to apply the formula, that's it". This teacher seemed to give contradictory answers to the question. Initially she pointed out that it is important for students to have an adequate understanding of the concept of mole in order to solve the problem, however when pressed further, she seemed unsure of herself. This uncertainty may be caused by the teacher's inadequate understanding of the concept. Even though the researcher did not ask the teachers to explain the concept of mole in this interview, it could be discerned that some teachers could also had some misunderstandings of the concept. It would be so disappointing if teachers themselves perceive the concept of mole only as the written definition of the concept, without really understanding what it really means.

7. The effect of students' mathematical ability on their performance in stoichiometry problem solving

Teachers, however, have some disagreement on whether mathematical ability of the students would greatly influence their performance in stoichiometry problem solving. Two teachers (Teachers 1 and 4) seemed to perceive that a sound mathematical ability of the students would help them a lot in solving the stoichiometry problems. Yet, the other three teachers (teacher 2, 3 and 5) do not seem to agree with this. They viewed that even students with minimal mathematical ability would be able to solve the problems if they had a sound understanding of mole ratio of reactants and products, and an adequate ability to translate the worded problems into correct mathematical equations.

In short, comparing the views given by these teachers revealed some differences in their pedagogical approach in teaching the topic. The senior teachers seemed to rely heavily on the

algorithmic approach in her teaching. On the other hand, young teachers seemed more concerned about students' understanding and ability to use the correct mole formula in solving the problems. All teachers asserted that students' representation ability and the ability to use the correct mole ratio are the major factors that would determine students' success in stoichiometry problem solving. However, they also believed that students' conceptual understanding on the concept of mole and mathematical ability are not the important factors that would influence their performance in solving the problems.

B. Analysis of Students' perceptions

Ten students were randomly picked out from all the five classes of respondents that responded to the stoichiometry test earlier. The students were requested to answer 6 written subjective interview questions about stoichiometry problem solving. The analysis is summarized as follows:

1. Importance of the stoichiometry topic to chemistry students

Most students seemed to be aware of the importance of the topic but they could not quite put their finger on the reason. Some smart students (student 1, 2, 3 and 10) posited that the topic is very important because 'it links with the other topics in chemistry, and it involves a lot of calculations'. They seemed to be rather vague about the importance of the topic.

2. Students' views on the difficulty of the topic of stoichiometry

Many of them do not consider that stoichiometry is a difficult topic to understand (student 1, 2, 3, 8, 9 and 10). They seemed to give an impression that it is an easy topic to learn. Some (student 1, 2 and 3) perceive the topic is just a matter of plugging in the correct numbers into the formula. This could be explained from the students' view that solving the problems only involves simple calculations.

3. Students' major difficulties in learning the topic

The terms 'mole' and 'molecule' are the most common misunderstood terms in this study. This misunderstanding seemed to stem from the lack of students' understanding that particles may exist in the forms of atoms, molecules or ions. Almost half of the number of students seemed unaware that the difference between 'mole' and 'molecule' (students 6, 7, 8 and 9). The close resemblance in the phonetic pronunciation and spelling of the two words seemed to trigger the confusion. In fact some students thought that the two terms are identical, have the same meaning and can be used interchangeably, "1 mole contains 1 molecule" (students 2 and 9).

Since quite a lot of new terms are being introduced all at once, within the topic of stoichiometry, which often sound similar to each other or include related concepts (e.g. the 'mole', 'molecule', 'molar mass', 'amount of substance', 'number of particles', etc.), beginners in stoichiometry should be given a chance to review these definitions while practicing stoichiometric problems. This seems also appropriate because many misconceptions are likely to arise when definitions and connections of these terms and concepts are misunderstood.

4. Students' views on the factors that contribute to students' success in solving the problems

When asked about factors that would contribute to their success in solving stoichiometry problems, some students (student 1 and 5) seemed to agree that translating a worded problem into an appropriate mathematical equation would determine the success of the exercise. Student 1, 2 and 10 said that it is also important they start with a balanced chemical equation. However, their problem solving exercise showed that only student 2 tried to balance the equation first. Student 1 and 10 might be so careless in their haste to finish the questions as quickly as possible, that they did not

balance the equation first. Interestingly, two students (student 3 and 10) pointed out that getting the correct 'mole fractions' of the reactants and products are also crucial to solve the problem, so that they could plug in the correct numbers into the formula.

In short, students implied that the ability to balance the chemical equation, to determine the correct mole ratio and the ability to translate a worded problem into a correct mathematical are the three important factors that contribute to their success in solving the problems.

5. Students' views on the influence of their understanding of the concept of mole on their performance in stoichiometry problem solving

More than half of the number of students (student 1, 2, 5, 6, 8 and 10) agreed that the understanding of the concept of mole influences their performance in solving the problems. However, most of them were more concerned in using the correct formula to calculate the mole of substances. The students could not explain that a sound understanding of the concept of mole would help them to determine the appropriate formula to use in calculating the mole. The weaker students seemed comfortable with just memorizing all the possible mole formula to help them in solving the problems. Nevertheless, due to their lack of understanding of the mole concept, they sometimes used the wrong formula. This particular finding has made the researcher realized that a teacher should made it clear to her/his students that the understanding of the concept of mole is not just useful to answer theoretical questions, but also would be crucial when engaging the correct formula in stoichiometry or any other chemistry calculations.

6. Students' views on the influence of mathematical ability on their performance in stoichiometry problem solving

Almost all students (all students except student 4 and 7) seemed to think that mathematical ability influences their ability to solve the problems. However, they indicated that only minimal mathematical ability is needed to solve the problems. Since solving stoichiometry problems do not require one to solve 'calculus' problems, they viewed that even with low mathematical ability, they would be able to solve the 'simple' calculations.

Conclusion

The MRA showed that students' problem representation ability is the most dominant factor that would influence their success in stoichiometry problem solving. The model suggests that students' problem representation ability and their understanding of the concept of mole are the two major determinants of students' performance in stoichiometry problem solving. In other words, students need to be able to have the conceptual understanding of the problem, namely, being able to translate the worded problems into a suitable chemical and mathematical equation, and using the correct formula to calculate the mole, before they can solve the problem.

The qualitative analysis of the interview supports the statistical analysis of the test. This indicates teachers should be aware that many students have some difficulties in 'making sense' of the chemical reaction itself. This contributes to the students' difficulties in translating the worded problem into a suitable mathematical equation. To conclude, in the teaching and learning sessions in the classroom, teachers should not practice the 'short cut' approach (algorithmic methods) in the entirety. Students ought to be exposed and guided to understand the mole concept very well. Teachers need to make the effort to make sure they could grasp the underlying conceptual foundation of stoichiometry before introducing the algorithmic way of solving the problems.

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Exploring Pre-Service Student Teachers' Experiences on Reflective Practice

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Abstract

Reflective practice is viewed as the best component for developing effective teachers. Reflections act as a tool to bridge between teaching knowledge and teaching practice. This study draws on the perceptions of pre-service student teachers' on the practice of writing reflections in the Bachelor of Teaching (Hons.) TESL program. The purpose of this study is to examine student teachers' perceptions whether or not writing reflections would help them to develop understanding in teaching knowledge. It also aims at evaluating whether or not the goals of the Institute of Teacher Education Malaysia (ITEM) such as 'developing knowledgeable, competent and expert teachers through reflective practice' had been fulfilled. This study had been carried out over a period of six weeks. Three student teachers were interviewed using semi-structured interview schedule. Student teachers were also asked to write an overall reflection based on a course which they had attended in the program – the reflections focused on what they had learned during the course. The reflections were analysed based on emerging themes. Findings from this study had indicated that writing reflections seemed to be helpful to student teachers' understanding in teaching knowledge.

Keywords: reflective practice, writing reflections, teaching knowledge

Introduction

Institut Pendidikan Guru Malaysia (IPGM) or Institute of Teacher Education Malaysia (ITEM) is a higher institution specialised in training teachers in various fields to fulfil the vision of the Ministry of Education Malaysia in developing primary school teachers at degree level. The programs offered at ITEM are designed to provide knowledge, experience and skills that enable teachers to perform successfully in the education profession. The aim of the Bachelor of Teaching program or *Program Ijazah Sarjana Muda Perguruan* (PISMP) is to produce teachers who are well trained, dynamic and competent; who are experts in their field of teaching based on the National Education Philosophy and Teacher Education Philosophy (*Institut Pendidikan Guru Malaysia*, 2012).

Currently, ITEM is implementing a revised teacher education curriculum that focuses on ‘project-based learning’ and ‘problem-based learning’ (*Institut Pendidikan Guru Malaysia*, 2012). Problem-based learning (PBL) shifts the traditional teaching of lecture-based to a constructivist perspective in learning. Here, the role of teacher educator is to guide and challenge the learning process rather than to strictly provide knowledge. From this perspective, feedback and reflection on the learning process are important components of learning. Students are active agents who engage in social knowledge construction. Problem-based learning contributes to the process of creating meaning and building personal interpretations of the world based on experiences and interactions. Problem-based learning in teacher education will guide student teachers to make connections between theory to practice.

Project-based learning also contributes quite significantly to the teacher education curriculum. Project-based learning promotes the idea of ‘learning by doing’ as suggested by Dewey (1933). It also integrates ‘knowing and doing’ (Markham, 2011) where student teachers do not only acquire knowledge and elements of the core curriculum but also apply what they know to solve authentic problems and produce significant results. Project-based learning re-enforce the practice of writing reflections because learning is activated through experience.

These two teaching and learning strategies have brought about change in how teacher educators develop their student teachers in teacher education institutes in Malaysia. They promote opportunities for reflective practice. Reflective practice is viewed as the best agent for developing effective teachers. Teachers who practices writing reflections are ‘constantly changing, both in terms of their understanding of the factors which shape classroom learning, their planning for lessons and learning activities and their classroom teaching’ (Kiely, 2013). The awareness that develops in the teachers will bring about change in practices. Subsequently, these ‘thinking teachers’ will become effective teachers that are able to function at many different levels as desired by the current teacher education curriculum.

Statement of Problem

The main purpose for the current teacher education institute to implement the new teacher education curriculum is to develop teachers who are ‘knowledgeable, competent and an expert in their field of the teaching profession’ (*Institut Pendidikan Guru Malaysia*, 2012). The desire to develop such teachers can be done through the inclusion of reflective practice or reflective activities through problem-based learning or project-based learning strategies. However, based on the quality and the level of reflections that the student teachers write, it is assumed that these student teachers are merely writing their reflections for the sake of assessment purposes or to fulfil the requirement of the course during teaching practice. After 6 semesters of providing opportunities to pre-service student teachers for reflective practice in and outside the training classroom, it is not clear if the reflections helped them to establish a connection between theory and practice.

Additionally, some of the reflections that the student teachers write were mainly reports of their learning process which vaguely shows whether they have gained anything from the practice of

writing reflections. Thus, it is assumed that the ITEM's intention of developing competent and effective teachers through reflective practice is rather vague.

Purpose of the Study

This study seeks to explore Semester 6 Bachelor of Teaching TESL student teachers' perceptions whether or not writing reflections would help them to develop an understanding in teaching knowledge. It also aims at evaluating whether or not the goals of the ITEM such as 'developing knowledgeable, competent and expert teachers through reflective practice' can be achieved.

Research Questions

This study is based on the following research questions:

RQ1 : How do student teachers perceive writing reflections in the Bachelor of Teaching TESL program?

RQ2 : How has reflective practice been successful in developing student teachers' teaching knowledge?

RQ3 : Has the practice of writing reflections in the Bachelor of Teaching TESL program been successful in developing student teachers who are knowledgeable, competent and an expert in the field of teaching?

Literature Review

Reflection and Reflective Practice

Shulman (1987) and Cruickshank (1986) view reflection as an important element in learning to teach. Reflection when used as a tool for linking practice to theory, it contributes significantly to the student teachers' understanding of the process of teaching. Dewey (1933) considers reflection as a special form of problem-solving and thinking to resolve an issue; an active reasoning process. Student teachers who are involved in writing reflections develop knowledge of the self and new understandings of teaching. They construct understanding based on their experience.

Darling-Hammond (1995) in Hoban (2000) believes that one of the main goals of a teacher education programme should be to produce graduates who have a deep understanding of teaching and learning and can use this insight in their future classroom practices. To achieve this, pre-service student teachers need to understand and realise the change and development that happen during classroom teaching and learning which can be achieved through reflective practice.

Wright (2010) mentioned that the practices of 'reflection' and the notion of a teacher learning to become a 'reflective practitioner' have become established elements of second language teacher education programmes worldwide as part of the process of lifelong professional development. By introducing reflective practice to the pre-service student teachers, it can help them gain knowledge, understanding and raise awareness of meaningful and effective classroom practices.

Reflections and the practice of writing reflections are essential for teachers in Malaysia since the new teacher education curriculum is shifting learning from trainer-centred to autonomous learning. This increased focus on self as inquirer has resulted in greater importance being placed on preparing pre-service student teachers to become reflective practitioners (Ussher, 2001 in Ussher & Chalmers, 2011).

There is limited learning without reflection (Schön, 1983). Opportunities for reflection will enable teachers to write and talk about observations, thinking, reading and practice, as greater learning value occurs when teachers interrogate events particularly through dialogue (Ghaye & Ghaye, 2001; Maloney & Campbell-Evans, 2002 in Ussher & Chalmers, 2011). In order to interrogate events and practices over time and with others effectively, it is essential to have a written

record of both the actual event and own thinking. Journal writing or learning log is an appropriate tool to achieve this goal.

Research Methodology

This is an explorative study which took 6 weeks to complete. Data were collected based on interviews conducted with 3 Semester 6 TESL student teachers undergoing the Bachelor of Teaching program. They were student teachers which I have supervised for teaching practice. These student teachers were interviewed with semi-structured interview questions (Appendix A). The interviews were recorded, transcribed and analysed according to themes.

19 student teachers who took TSL3111: Developing and Using Resources for the ESL Primary Classroom were asked to write an overall reflection at the end of the course. The reflections focused on what they had learned in the course. However, only 6 student teachers submitted their reflections. These reflections were used in this paper and analysed according to emerging themes.

Findings

The Interviews

Seven interview questions were constructed to guide me in exploring pre-service student teachers' experiences in writing reflections. Throughout the interviews, I have kept very closely to the questions except for Question 2 (Appendix A) where I have to rephrase and clarify 'teaching knowledge' to the respondents. On several occasions I also had to ask additional questions to gain further clarification on issues stated by the student teachers.

Based on the responses in the interviews, I was able to identify three main themes. They are i) awareness in teaching, ii) effective reflective practice, and iii) guidance and feedback.

Awareness in Teaching

Firstly, all student teachers agree that writing reflections is helpful and practice is also successful in making aware of and realising one's own weaknesses and strengths in teaching.

ST 1: I think it is good because err by writing our own reflection we can see our... strong and weaknesses err in one thing for example in teaching err we reflect back what we have done during the class and we can improve our err for the next class.

For example for today's class, I make mistakes in pronunciation, for example, so for the next class I have to improve the pronunciation. err for example by taking in, by using the online dictionary or the dictionary that we install in our laptop for example so that we won't make the same mistake in class.

ST 2: Writing reflection urm is err quite useful especially during my practicum and for my assignments because err it helps me reflect on what I did throughout the process because maybe I didn't realise that err learn this or I have err how to say it gone through certain stages for doing it but after I gone through the reflection I can identify what I have learnt and or stages or every lesson that I did.

Err yes, err especially during practicum. When I read my reflection I am able to see what went on in my lessons so next lesson I have to improve on an aspect so definitely it helps.

ST 3: Yes. I do not aware about my mistakes during lesson so after doing reflection I only then err I can see err where the mistakes where maybe the or maybe lesson where have been disturbed during lesson so after doing reflection I am aware of my progress in lesson so err improve it in the next lesson.

Effective Reflective Practice

The student teachers felt that there are two situations where writing reflections can be an effective practice which is during teaching practice or practicum and when doing reflections for assignments.

ST 1: err I think during the practicum compared to others because err for example err for example the portfolio umm it is so general to reflect but for practicum err err its err focused for each day so we make same reflection everyday compare to the portfolio for example for the last semester err baru kita buat urm the reflection so...focus for the practicum, it focus more la...

ST 2: Umm I say coursework or project work assignment because I will relate what I learn from the course the most than during practicum because in school because certain theory cannot be applied so I can't relate it or it did not come into my mind when I need to but for coursework or project work we will still be working on the same theory for reading it so many times already so I will be able to relate it. So it's most effective for my learning...course.

ST 3: err the most effective I think is during practicum after for every err after every lesson because or of course err after for example during observation err the lecturers or the teachers err will give their reports and their response about us so based on their response we can become more aware where the mistakes are where our lessons are disrupted err when maybe we have err oversee something in the class so using reflection by lecturers using reports by teachers we can add something to our knowledge by doing reflection.

Guidance and Feedback

Student teachers believed that in order to write good reflections, lecturers should give proper guidance and feedback.

ST 1: (nod) and more by having some feedback from the lecturers help me to write my reflection better because err err for example Madam shows me the...the thing that I did not notice...

ST 2: Yes because urm if we are not required to write reflections that we would be looking into our own mistakes or weaknesses because I think we still need to be taught or we need certain requirement to reflect on our teaching and everything we need.

Umm for every reflection I wrote during practicum my supervisor always check our reflection and comment on what to add. She is focused more on what about our emotional state, I mean what do I feel about the lesson instead of what you can see and what you think...what about your feelings. She thinks that feelings is one important aspect of reflection from that comments I started to focus on my feelings as well because of course every teacher would feel frustrated that or maybe some lessons or class so that is some of the ways to...even improve my reflection and for assignments if I get to see the assignment again and re-read it so it is one of the ways to improve my reflections.

Reflections

Three main issues were identified in the reflections. Firstly, student teachers stated that they had benefitted from the course in terms of knowledge and skills.

“Through this subject I have learned on how to adapt, exploit and design teaching materials for a classroom.”

“For me, this course really helps me to choose appropriate materials for my pupils and taught me how to design my own teaching materials besides checking the materials whether the materials are suitable for the pupils or not.”

“For my part, as ‘a selector’, ‘an adaptor’ and ‘evaluator’, I become more confident as might have become more critical about the textbooks used, an developed an awareness of the need to use the textbooks or any materials more creatively.”

“There are many new things that I’ve learned through this course, for example making a checklist on how to select the appropriate course book for our targeted learners, the important factors in selecting materials, and how to evaluate a material.”

Secondly, from the reflections, the student teachers gave instances that showed their ability to apply what they have learned from the course during teaching practice.

“For example, I made a checklist for them to ask around the class and find people who has the listed hobbies. Actually, the checklist was designed to ask question about pupils’ families, but I re-designed it to be favourite hobbies that suited my pupils’ interests.”

“For instance, I adapted a video of a song to suit my lesson and my students’ level.”

Thirdly, the student teachers expressed their views about the course, providing feedback and shortcomings in the course.

“For me, this course really helps me to choose appropriate materials for my pupils and taught me on how to design my own teaching materials besides checking the materials whether the materials are suitable for the pupils or not.”

“On the other side, I think one of the shortcomings of this course was that we are actually learning some of the content that we had learnt.”

“I like this course because it helps me to think critically in selecting, evaluating and adapting materials for my lesson. It is especially important for planning lessons, because in future, I might face very different groups of pupils constantly, every year.”

Discussions

The value of reflection stems from its role in aiding professionals, something that has been emphasized so they could progress in their practices (Schön, 1983). Also, the emphasis of it is value in developing a deep understanding of complex issues based on rational thought analyzing available evidence (Dewey, 1933). Numerous approaches have been used to promote reflection in education. However, reflection although seemed important often failed to show its value since there are small research evidence about their efficiency and success.

From my point of view as a teacher educator, reflection plays an important role in developing the pre-service student teachers to understand their work and look for new ways in learning to teach. I believe it will give student teachers the space they need to explore and be more confident. Moreover, it is a good way for student teachers to practice questioning oneself and discover the possibilities of teaching.

RQ 1 seeks to explore some of the student teachers’ perception of writing reflections in the Bachelor of Teaching program. The findings showed that most of the student teachers felt that writing reflections in the program is useful. Based on the interviews, student teachers stated that through reflections they became aware of what they were able to do in the classrooms and which part of teaching they need to improve. In the reflections, the student teachers described how they had discovered the new knowledge and this is evidence to reflections being a useful tool into self-discovery in the teaching program.

RQ 2 tried to identify whether reflective practice has been successful in developing student teachers’ teaching knowledge. Earlier I have mentioned that all student teachers during the interview were unclear of the phrase ‘teaching knowledge’. Here I would like to clarify that ‘teaching knowledge’ refers to the knowledge of teaching: the skills, methods, approaches, techniques or activities that are used to teach English to learners. In the reflections, student teachers were able to describe how they had used the skills they had acquired in the course during teaching practice. They have provided examples and even evaluate their own practices by expressing their satisfaction or

suggestions to improve their own teaching. This shows that the practice of writing reflections can develop a student teacher's knowledge of teaching.

RQ 3 is to determine whether the practice of writing reflection in the program is successful in developing student teachers who are 'knowledgeable, competent and an expert in the field of teaching'. The responses in the reflection show that the student teachers have acquired the teaching knowledge during the course. This makes them 'knowledgeable' when in the reflections there are evidence that show student teachers were able to make connections and apply what they learned in the course during teaching practice. Student teachers are 'competent' since they have the ability and skill to develop resources and materials to teach English. As for the 'expert' aspect, I feel that the student teachers need time and more experience to develop their teaching skills which eventually can be achieved.

One positive point that I would like to highlight, in the interviews student teachers have shown interests in writing good reflections when they requested for proper guidance and feedback after feeling dissatisfied with the quality of their reflections. They also expressed that writing reflections is difficult. Boud and Walker (1998) stated that using insufficient activities, without guidance there won't be beneficial results of reflection. Teacher educators themselves have to have the skills and knowledge about writing reflection so they can guide student teachers to write better reflections. At the moment, although some lecturers do provide some input mostly just leave the job for the practicum unit to handle the situation. The unit has taken the responsibility but by providing sample reflections alone is not enough. Clear framework is essential in providing better reflection practice to the students.

Conclusion

Integrating and implementing reflective practice into the pre-service teacher education curriculum has always not been easy. The focus of most teacher education programmes is mainly on the input or the transmission of knowledge from the lecturer to the students. However, this approach has to change with the 'transformation approach' (Kiely, 2013) that emphasis on exploration of the experience while learning to teach. By inserting reflective practice or the practice of writing reflections into the pre-service teacher education courses, it will strengthen the existing teacher education curriculum. This develops teachers who are independent and responsible for their own learning.

Korthagen (1993) drew attention to the lack of empirical evidence that reflection is effective. Even so, student teachers in the Bachelor of Teaching program believe that writing reflections is helpful and leads to 'self-awareness' and 'self-improvement' (Moon, 2008). The student teachers realised many aspects of teaching though the self-dialogue nature of writing reflections. Thus, the practice of writing reflections can develop student teachers who possess the knowledge of teaching and able to use the knowledge they have acquired in the classrooms.

Reflection is the key element in transforming traditional teacher training into explorative teacher learning. Furthermore, student teachers' reflections are rich with information about their experience in the process of learning to teach. This information is valuable in planning and developing better training courses in the future.

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Appendix A

Interview Questions

1. What is your opinion about writing reflections?
2. How has writing reflections helped you to develop your teaching knowledge?
3. Do you find any difficulties in writing reflections? What are they?

4. As a student teacher, do you think writing reflection is necessary?
5. You write reflections during teaching practice/practicum, school-based experience (SBE), in your learning log/portfolio, coursework/project work assignments; which one of these is the most effective? Why?
6. Were you given any form of guidance or help prior to writing your reflections? How did the lecturer help you?
7. What would you suggest to the lecturers to help you write better reflections?

Effect of Internally Generated Revenue on Economic Development of Sub-Saharan Africa: Evidence from Nigeria.

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Abstract

One of the characteristics of Nigeria's federal system of government is its revenue allocation system wherein the federal government allocates funds to each state of the federation based on certain predetermined percentages; a practice which is prevalent in Sub-Saharan Africa. This statutory allocation has been the major stream of income for most states in Nigeria for many years while Internally Generated Revenue by the states has been significantly low. While the statutory allocation is determined by the federal government, the states have the sole responsibility of generating revenue internally. Internally generated revenue as it were, is the quickest and most effective means of increasing state income as federal allocation is based on uneven predetermined percentages from the federal government.

In light of these, this paper seeks to analyse the effects of Internally Generated Revenue (IGR) on the economic performance of a state, using Ekiti state blessed some basic solid minerals in Nigeria, West-Africa as a case study.

We used secondary data collected from the Central Bank of Nigeria and Federal Office of Statistics analysing same using simple and multiple regression models.

Our findings showed that Internally Generated Revenue (IGR) has a positive correlation with Gross Domestic Product. Considering the dwindling federal allocations and the controversial allocation measures, it is therefore recommended that states should widen the net for their Internally Generated Revenue of Taxes, Rent, Earnings, Interests, dividends etc through opening up

undeveloped areas in the State, Tax justice and implementation of past scientific reports on each of these items

Keywords: Revenue Allocation, Funds. IGR, Statutory, Earnings

Introduction

In most human societies, whether developing or developed, Government plays certain roles in economic development. Usually, Government is responsible for the provision of public goods and services largely due to the inherent characteristics (of public goods and services) and indeed as a result of market failure.

Provision of public goods and services such as construction of accessible roads, construction of bridges, building of public schools, health care centres etc require huge resources (revenues). Worlu and Nkoro (2012) submit that the infrastructural developments demand a lot of resources and funding. Similarly, Adesoji and Chike (2013) maintain that the need for state and local government to generate adequate revenue from internal sources has become a matter of extreme urgency and importance. Taxation has been found to be a veritable tool of revenue mobilization, although there are some challenges in the revenue drive. According to Akintoye and Tashie (2013) opine that in the world over, taxes is one major source of government revenue, however, not every national government have been able to effectively exploit this great opportunity of revenue generation. Akintoye and Tashie (2013) further assert that ineffective revenue generation can be attributed to a number reasons including the system of taxation; tax legislation; tax administration and policy issues; over reliance on other sources of revenue (such as foreign aid and grants); corrupt practices in the system – especially as it relates to the system of tax collection and behaviour of citizens towards tax payment; and ease of tax payment.

The ability of the different tiers of government in a country to mobilize revenue depends on the adopted political arrangement. Political arrangement determines who gets what. Nigeria as a nation practices federalism. Historically, Nigeria became a federal state with the advent of Richards Constitution in 1946. According to Oates (1972), Federalism is defined as the amalgam of sub-units of national sovereign governments that operate independently under a constitutionally defined sphere of functional competence.

The thrust of fiscal arrangement in federalism is built on the assignment of powers and responsibilities to each level of government. It is further believed that each level of government should have adequate funds to effectively and efficiently discharge its responsibilities. In fact, decentralization of responsibilities for expenditure and revenue to different levels of government ensures that each government makes decisions and allocates resources according to its own priorities.

There is, however, a grave mismatch between assigned responsibilities and revenue distribution among the federating blocks in Nigeria. Odoko and Nnanna (2009) affirm that the challenges of intergovernmental fiscal relationship in Nigeria hinge on the equity of the expenditure assignment and revenue-raising functions amongst the three tiers of government. This fiscal imbalance is a product of assigning high-yielding revenues types to the central government while substantial and growing expenditures are devolved to the sub-national governments. According to Emenuga (1993), the allocation of revenue to the different tiers of government has not adhere strictly to the expenditure requirements of each tier, thus the federal government has become a surplus-spending unit while other functions, he proposes the determination of a tier's share through the aggregation of its basic expenditure needs.

The fiscal imbalance leaves states and local governments with no viable option other than to map out strategy for enhancing internally generated revenues beyond allocations from federation account. Kiabel and Nwokah (2009) posits that the increasing cost of running government coupled

with dwindling revenue has left various state governments in Nigeria with formulating strategies to improve the revenue base.

Internally generated revenues to state governments are set out in the 1999 Constitution of the Federal Republic of Nigeria. States are legally empowered to levy taxes partly or solely on the following: Capital gains Tax, Personal Income tax, Stamp Duties, Pools Betting & Other Setting Taxes, Motor Vehicle and Drivers' Licenses, Entertainment Tax, Legal Registration & Survey Fees and Gift Tax, Rent, Earnings, Dividends etc (1999 Constitution of the Federal Republic of Nigeria).

Improved internally generated revenue in states is a panacea to fiscal autonomy.

Concept of Internally Generated Revenue

Internally generated revenues to state governments are set out in the 1999 Constitution of the Federal Republic of Nigeria. According the Constitution, States are legally empowered to levy taxes partly or solely on the following: Capital gains Tax, Personal Income tax, Stamp Duties, Capital Transfer Tax, Pools Betting & Other Setting Taxes, Motor Vehicle and Drivers' Licenses, Entertainment Tax, Legal Registration & Survey Fees and Gift Tax.

Economic Development

Economic development generally refers to the sustained, concerted actions of policy makers and communities that promote the standard of living and economic health of a specific area. It can also be referred to as the quantitative and qualitative changes in the economy. Such actions can involve multiple areas including development of human capital, critical infrastructure, regional competitiveness, environmental sustainability, social inclusion, health, safety, literacy, and other initiatives(Akintoye & Tashie, 2013).

Federalism

Federalism is a type of government in which sovereignty is constitutionally divided between a central governing authority and other federating units (such as states, provinces or local governments). The power to govern is democratically shared between national and provincial/state governments, creating what is often called a [federation](#)(Ajayi, 1997).

Theoretical Framework

The effect of Internally Generated Revenue on Economic Development can be examined within the theoretical frameworks of public goods and fiscal federalism. Agu (2010) opined that discussions about internally generated revenue of sub national government are located within the framework of the theory and practice of fiscal federalism.

The intervention of government in the economic activities of any nation is justified in the theory of public goods.

Samuelson (1954), credited as the first economist to develop the theory of public goods defined public goods as "...goods which all enjoy in common in the sense that each individual's consumption of such a good leads to no subtractions from any other individual's consumption of that good..."

Theoretically, it is generally believed among economists that private markets allocate goods and services among individuals efficiently under given circumstances. It is further accepted that no waste occurs and that individual tastes are matching with the economy's productive abilities. In many cases, however, it is found that conditions for private market do not hold thereby resulting in market failure and the inevitable interventions of governments.

Many reasons can be adduced for the intervention of governments in provisions of public goods. Private markets, for instance, do not have the interests in providing public goods because of the very nature of public goods. Besides, Oates (1994) submitted that Private markets cannot earn

sufficient revenues from selling the public good to induce them to produce the socially optimal level of the public good.

Similarly, Market failure arises from the divergence between private and social costs or benefits and leads to inefficient resource allocation as well as development outcomes that may not be socially optimal (Eboh, 1999).

Public goods could be regarded as goods or services that can be consumed by several individuals simultaneously without diminishing the value of consumption to any one of the individuals. Public goods are non-rivalry as they are non-excludability. Non-rivalry means that multiple individuals can consume the same good without diminishing its value whilst non-excludability connotes that an individual cannot be prevented from consuming the good whether or not the individual pays for it. Fresh air, a public park, a beautiful view, national defence etc are examples of public goods.

Musgrave and Musgrave (1989) mentioned three kinds of public goods namely: pure public goods, impure public goods and private goods. They further averred that private goods are consumed individually and its consumption is contingent upon payment while impure public goods are those collectively consumed but its consumption is contingent upon payment. Whereas, pure public goods are collectively consumed but consumption is not contingent upon payment - characterized by non-exclusivity and non-rivalry.

The concept of Federalism needs to be defined before dwelling on fiscal federalism. For Arowolo (2011), Federalism is a coinage of a Latin word “foedus” meaning covenant. It is a political arrangement in which sovereignty is constitutionally shared between a central governing authority and constitutional political units (like states, provinces, local governments as the case may be).

According to Ajayi (1997), federalism is the juxtaposition of two levels of power of a central government otherwise called the federal government and other states labelled variously as states, regions, republics, cantons or unions.

Federalism is a system in which the power to govern is shared between national and state governments, creating what is often called a federation (Akindele and Olaopa, 2002). Federalism is about how power is distributed or shared territorially and functionally among the various units in a federation.

In the same dimension, Sagay (2008,) opines that federalism is as an arrangement whereby powers within a multi-national country are shared between a federal government and component units in such a way that each unit, including the central authority exists as a government separately and independently from others, operating directly on persons and properties with its territorial area and with a will of its own apparatus for the conduct of affairs and with an authority in some matters exclusive of others.

Fiscal Federalism is an off-shoot of the decentralization theorem. According to Oates (1972), the theorem is built on the assumption that in the absence of cost-savings from the centralized provision of a [local public] good and of inter-jurisdictional externalities, the level of welfare will always be at least as high (and typically higher) if Pareto-efficient levels of consumption are provided in each jurisdiction than if any single, uniform level of consumption is maintained across all jurisdictions.

The theorem thus establishes, on grounds of economic efficiency, a presumption in favour of the decentralized provision of public goods with localized effects.

Fiscal federalism is premised on “understanding which functions and instruments are best centralized and which are best placed in the sphere of decentralized levels of government” (Oates, 1999).

In other words, fiscal federalism is the study of how competencies (expenditure side) and fiscal instruments (revenue side) are allocated across different (vertical) layers of the administration. An important part of its subject matter is the system of transfer payments or grants by which a central government shares its revenues with lower levels of government.

Musgrave (1959) and Oates (1972) cited in Oates (1999) contend that the traditional theory of fiscal federalism lays out a general normative framework for the assignment of functions to different levels of government and the appropriate fiscal instruments for carrying out these functions. Oates (1999) submits that at the most general level, this theory contends that the central government should have the basic responsibility for the macroeconomic stabilization function and for income redistribution in the form of assistance to the poor.

Besides, it is widely assumed that the central government must provide certain “national” public goods (like national defence) that provide services to the entire population of the country (Oates, 1999).

Empirical Review

Unegbu and Irefin, 2011 opines that Economic development typically involves improvements in a variety of indicators such as literacy rates, life expectancy, and poverty rates.

Adejoh and Sule (2013) quoting Ake (2001) also define Development as the process by which people create and recreate themselves and their life circumstances to realize higher levels of civilization in accordance with their own choice and values. It also a type of social change in which new ideas are introduced into a social in order to produce higher per- capital income and levels of living through more modern production methods and improved social organization.

Gordon (1983) emphasised that the extensive application of non-benefit taxes on mobile factors at decentralised levels of government could result in distortions in the location of economic activity. Following from the assignment of functions, taxes that matched more effectively the assigned functions were also assigned to the relevant tier or level of government. Progressive income tax is suited to the functions of income redistribution and macro-economic stabilisation and is therefore assigned to the central government. Whereas, property taxes and user fees were deemed more appropriate for the local governments. Benefit taxes are also prescribed for decentralised governments based on the conclusion that such taxes promote economic efficiency when dealing with mobile economic units, be they individuals or firms (Ozo-Eson, 2005).

Fiscal imbalance requires fiscal equalisation. This involves transfers of lump sum from the central government to decentralised governments. The need for equalisation is based on two main arguments. The first which is on efficiency grounds sees equalisation as a way of correcting for distorted migration patterns. Again, it is thought-of that equalisation provides assistance to poorer regions or jurisdictions.

Equalisation has been important in a number of federations (Arowolo, 2011). For example, Canada has an elaborate equalisation scheme built into her inter-governmental fiscal arrangements (Weingast, 1995).

It should be pointed out however, that recent literature emphasises the importance of reliance on local revenues for financing local budgets. A number of authors (Weingast, 1995; McKinnon, 1997) have drawn attention to the dangers of decentralised levels of government which rely too heavily on intergovernmental transfers for financing their budgets.

Divergent views have been expressed on the usefulness of decentralisation.

Oates (1993) argues that there are surely reasons, in principle to believe that policies formulated for the provision of infrastructure and even human capital that are sensitive to regional of local conditions are likely to be more effective in encouraging economic development than centrally determined policies that ignore these geographical differences.

Kim (1995) uses rates of economic growth and revenue decentralization to show that there are positive and statistically significant changes, using a sample of countries. The study also shows that, other things being equal, more public revenue decentralization resulted in more rapid growth in GDP per capita during 1974-1989 periods.

However, Prud'homme (1995) contends that decentralization can increase disparities, jeopardize stability, undermine efficiency and encourage corruption. He maintains that local authorities, for example, have few incentives to undertake economic stabilization policies. The instrument of monetary and public revenue policies are better handled by the central government.

Fiscal federalism has a long history in Nigeria. Fiscal federalism crept into Nigeria with the introduction of Richards Constitution in 1946.

Today, the Nigerian Federation is made up of 36 states, the federal capital territory with a near status of a state and 774 local governments. However, Ewetan (2012) observes that long years of military rule and the centralized nature of the military hierarchical structure created the financial hegemony enjoyed by the federal government over the thirty states (36) states and seven hundred and seventy four (774) local governments. This phenomenon has created disaffection in the Nigerian federation leading to worry over the development of a national and functional fiscal federalism for Nigeria.

Studies on tax and public revenue mobilization in Nigeria have shown a high degree of centralization. According to Emenuga (1993), the allocation of revenue to the tiers of government has not adhered strictly to the expenditure requirements of each tier, thus the federal government has become a surplus-spending unit while other functions, he proposes the determination of a tier's share through the aggregation of its basic expenditure needs.

To reduce the gap between tax power and responsibilities, two types of revenue sources are allocated to each tier. These are independent revenue sources and direct allocation from the federation to which centrally collectable revenues are paid. Local government also receives allocations from state Internal Revenues. An agreed formula for vertical revenue sharing is used in sharing funds from the federation account.

Taxation is a veritable source of revenue to government that can be employed to fund development projects, among other uses.

Anyanwu (1997) cited in Akintoye&Tashie (2013) defined taxation as the compulsory transfer or payment (or occasionally of goods and services) from private individuals, institutions or groups to the government.

In the parlance of economists, a tax is a non-penal, yet compulsory transfer of resources from the private to the public sector levied on a basis of predetermined criteria and without reference to specific benefit received. It is a form of imposition in terms of charges on citizens (private and corporate) and products or services consumed by them as revenue to government. Nzotta (2007) cited in Akintoye&Tashie (2013) presented four key issues to be understood for taxation to play its functions in the society. First, tax is a compulsory contribution made by the citizens to the government and for the general common use. Secondly, a tax imposes a general obligation on the tax payer. Thirdly, there is a presumption that the contribution to the public revenue made by the tax payer may not be equivalent to the benefits received. Finally, a tax is not imposed on a citizen by the government because it has rendered specific services to him or his family.

Although, the primary purpose of taxation is to generate revenue for the government, it provides basis for the formulation of political, economical and social policies (Owolabi, 2006). Taxes are means of controlling inflation, promoting economic growth and off providing social amenities to the people. Ajayi (2004) noted that tax objectives in Nigeria can be realized if tax laws in the country are; reviewed to ensure collection of returns, filing of returns, imposition of;

penalties for late remittance, certification of tax debit through filing of writs, holding directors responsible for deliberate tax avoidance and evasion, imposition of interest on tax debt and legal warnings to tax debtors and failure to pay.

Siwisa (2005) identifies some of the reasons for low level of development in Africa as deficiencies in the tax collection system, tax evasion, corruption, abuse and misapplication of tax exemption, political interference and low capacity of the tax collection agents.

Omoigui-Okauru (2012) cited in Oseni (2013) asserted that states are often considered poor in the areas of internally generated revenue because most of them do not have a comprehensive data on who should pay tax or the key economic activities that can generate tax income, stressing this has always affected the revenue flow from internally generated sources.

Ojo and Owojori (1998) attributed the causes of poor internally generated revenue to lack of adequate resources such as vehicles and personnel for Mobilizing IGR at local government levels, the potential sources of IGR at each local government not being adequately tapped and the potential payers of taxes, rates and charges not willing to pay due to biases and other personal reasons.

Oseni (2013) opines that the absence of good and vibrant informal sector coupled with few industries will cause internal revenue to be low.

Akintoye and Tashie (2013) analysed the Effect of Tax Compliance on Economic Growth and Development in Nigeria, West-Africa.

It was discovered in their study that many Nigerians are complying with tax payment and that the willingness of citizens to pay tax in Lagos State is significantly higher than that of Oyo State.

Ogbonna and Ebimobowei (2012) worked on Impact of Tax Reforms and Economic Growth of Nigeria: A Time Series Analysis. Their various test show that tax reforms is positively and significantly related to economic growth and that tax reforms granger cause economic growth.

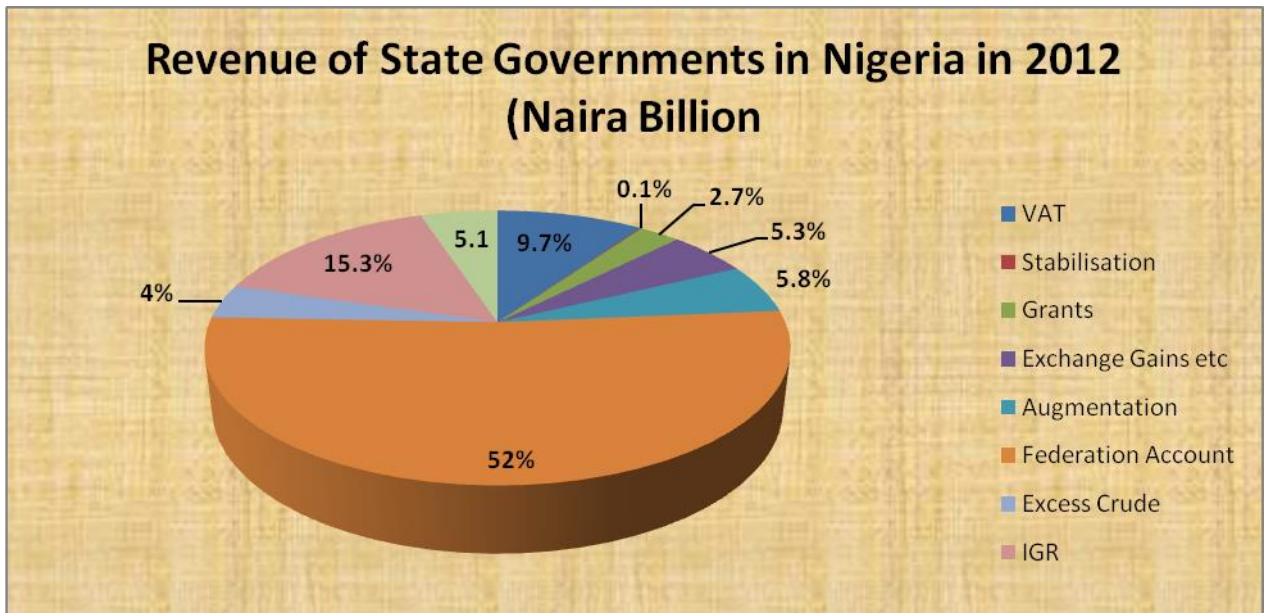
Nnanseh and Akpan (2013) assessed the effects of internally generated revenue on infrastructural development in AkwaIbom State. They found that IGR contributed significantly and positively to the provision of water, electricity and roads. It was however discovered that the contributions were skewed more to roads than electricity and water. It was concluded that IGR has made positive, but uneven contribution to the development of infrastructures in the State as some aspect of infrastructure like road was found to receive more boost from IGR than other infrastructures. They recommended a balanced approach to IGR appropriation for infrastructural renaissance in States.

Item	State Governments' Revenue				Share in Overall GDP	
	2011		2012		2011	2012
	Amount (N' Billion)	Share (%)	Amount (N' Billion)	Share (%)	(%)	(%)
Federation Account	1,786.3	52.4	1,857.0	52.0	5.0	4.6
Excess Crude Revenue	696.6	20.5	542.4	15.1	2.0	1.3
VAT	318.0	9.3	347.7	9.7	0.90	0.9
Internally Generated Revenue	509.3	14.9	548.1	15.3	1.4	1.4
Stabilization Fund	11.2	0.3	1.3	0.1	0.03	0.0
Grants & Others	88.7	2.6	95.7	2.7	0.3	0.2
Others			180.4	5.1		0.4

Source: CBN Annual Report (2012)

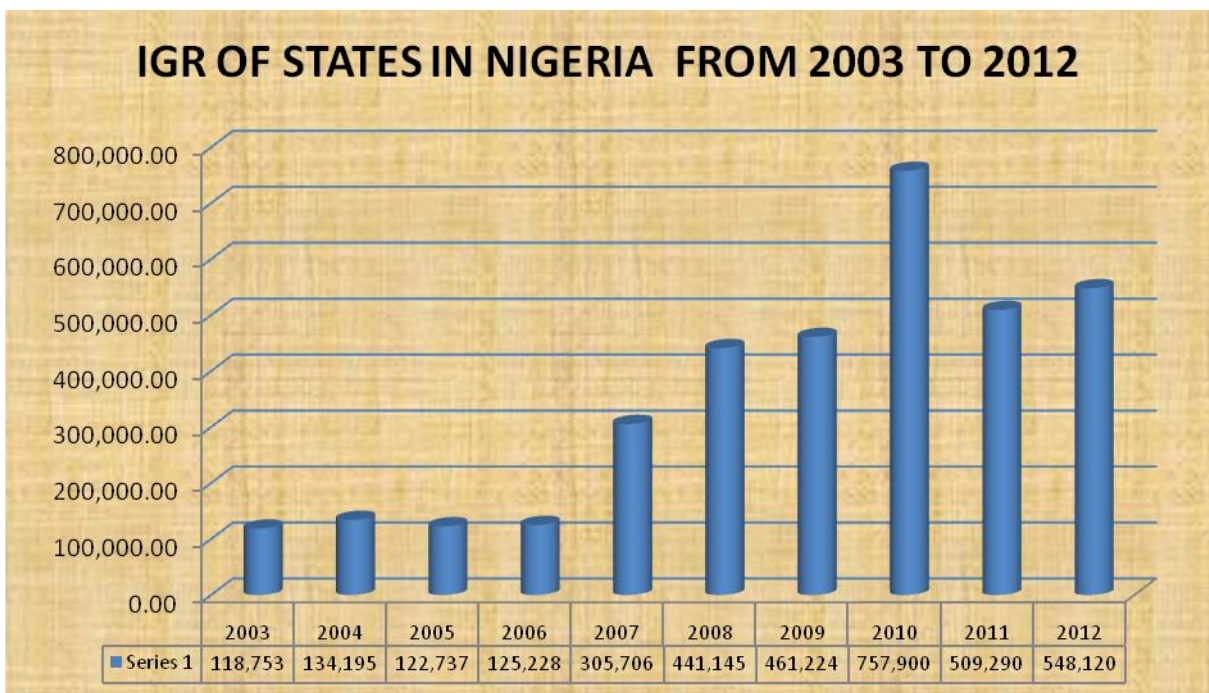
Internally Generated Revenue (IGR) was N548.1 billion, or 15.3 per cent. The IGR increased from the level in 2011 by 7.6 per cent, indicating an improvement in the drive for internal revenue. In terms of tax effort, measured as the ratio of IGR to total revenue (IGR/TR), Lagos State ranked highest with 53.4 per cent, followed by Kano and Ogun states, with 35.0 and 31.1 per cent, respectively, while Benue State ranked lowest with 1.9 per cent.

In terms of state governments' effort at improving internally-generated revenue, Sokoto State came first with an increased IGR/TR ratio of 16.2 per cent, from 5.1 per cent in 2011, followed by Yobe and Ebonyi states in the second and third positions, respectively. Overall, the consolidated IGR/TR ratio of the state governments rose from 14.9 per cent in 2011 to 15.3 per cent in 2012.



Source: CBN Annual Report (2012)

The graph below shows IGR generation among states in Nigeria from 2003 to 2012:



Source: CBN Statistics (2012)

Ekiti State in perspective

Ekiti State of Nigeria was created on 1st October, 1996 alongside other five states by the late Head of State and Commander-in-chief of the Armed Forces of the Federal Republic of Nigeria, General Sani Abacha-GCON, in a Nationwide broadcast to mark the 36th Independence Anniversary of Nigeria. The State which was carved out of the old Ondo State has its headquarter located in Ado-Ekiti and it covers twelve local government areas that made up the Ekiti Zone of the old Ondo State. However, Ekiti State on creation took off with sixteen local government areas, having had additional four carved out of the old ones.

Ekiti State is one of the thirty six (36) states (including the Federal Capital Territory Abuja) that now form the Federal Republic of Nigeria.

Major Tourist Centers/Attractions

Major tourist centres/attractions are listed in the table 2.4 below:

S/N	LOCATION
1	Ikogosi Warm Springs Resort Centre, Ikogosi-Ekiti
2	Fajuyi Memorial Park, Ado-Ekiti
3	Erinta Water Falls, Ipolelloro-Ekiti
4	Olosunta Hills, Ikere-Ekiti
5	Ero Dam, Ikun-Ekiti
6	Egbe Dam, Egbe-Ekiti

Source: Ekiti State Official Diary (2011)

Mineral Resources

Ekiti State is rich in mineral resources, most of them still untapped. The resources include cassiterite, columbite, tantalite, ceramic clays, kaolinitic clays, feldspar, bauxite clay, dimension stones, mica etc as depicted in table 2.6 below:

S/N	Types of Mineral	Town	Local Government Area	Industrial Uses/product
1	Clay Kaolin	Isan-Ekiti	Oye	Retracteries Manufactures, Chemicals, Industrial Abrasive, Ceramics Wares, Pharmaceuticals, Fertilizers, White Tiles, Insulator Wares, Pencils.
2	Cassiterite& Tin Ore	Ijero- Ekiti	Ijero	Tin Planting, Tin Can, Alloys, Printing and Dying
3	Columbite	Ijero-Ekiti	Ijero	Special Steel, Electronic Tube, Filaments in Rackets and Air Craft Manufacture
4	Bauxite (Aluminum Ore)	Orin-Ekiti	Ido/Osi	Aluminum Products Production
5	Foundry Sand	Ijero-Ekiti	Ijero	Foundry Ceramics, Manufacture of Glass Wares
6	Charnochite Granite	Ikere-Ekiti, Ado-Ekiti, Emure-Ekiti, Aramoko	Ikere, Ado, Emure, Ekit West	Stone Cutting & Polishing Road Aggregate

Source: Ekiti State Official Diary (2011)

Model Specification

The model of the relationship between Gross Domestic Product and Internally Generated Revenue is:

$$Y = f(X)$$

$$Y = \text{GDP}$$

X = Internally Generated Revenue

Then:

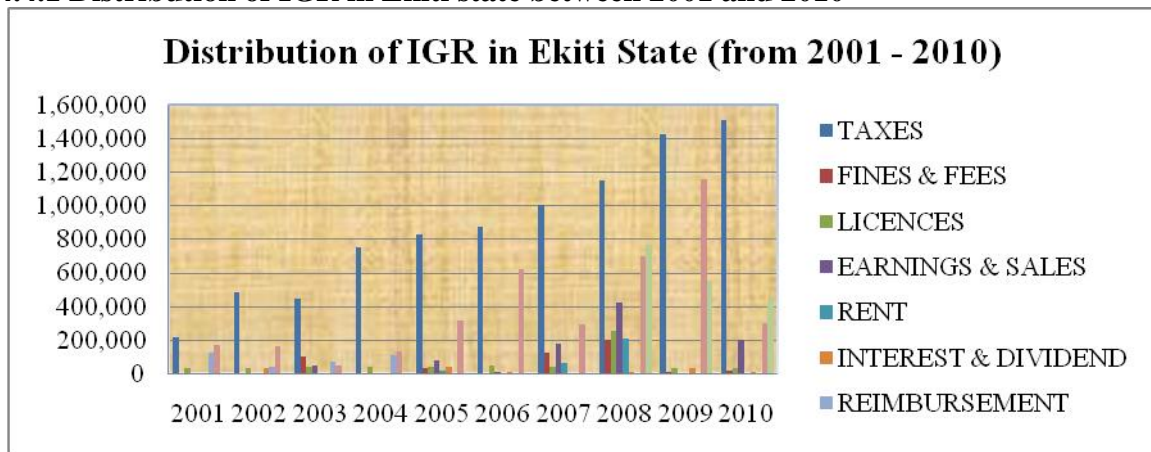
$$Y = b_0 + b_1 X + e$$

b_0 = parameter showing the point of interception with the Y – axis

b_1 = parameter also known as slope of the model defining the specific relationship

e = stochastic error term which is representing other variable that could cause a variation on the dependent variable which are not stated in the model

Table 4.4.1 Distribution of IGR in Ekiti state between 2001 and 2010



Source: Ekiti State Ministry of Finance (2014)

Table 4.4.2 Rate of Internally Generated Revenue (IGR), Statutory Allocation and Gross Domestic Product from 2001 to 2010

Year	Statutory Allocation(SA) (X ₁)	Internally Generated Revenue (IGR) (X ₂)	Gross Domestic Product(GDP) (Y)
2001	7,145,256,943.00	548,431,150.00	353,534,050,000.00
2002	6,732,964,012.01	747,276,459.76	366,914,070,000.00
2003	8,757,270,467.43	744,507,058.10	404,905,030,000.00
2004	13,064,653,491.32	1,038,459,474.72	541,502,884,355.40
2005	14,570,094,940.84	1,035,079,658.22	560,155,853,855.59

2006	16,206,928,230.88	1,192,255,057.27	606,150,053,816.17
2007	17,550,567,427.01	1,706,422,327.37	647,540,398,238.65
2008	21,187,003,418.77	4,153,780,092.56	688,142,881,416.86
2009	16,300,345,750.90	3,062,383,263.64	735,861,577,546.99
2010	20,896,614,606.25	2,454,450,646.20	793,551,206,069.93

Source: Ekiti State Ministry of Finance, 2013

Variable	From 2001 to 2010	
	\bar{X}	\pm SD
Internally Generated Revenue	1,668,304,518.78	1,188,866.66
Gross Domestic Product	569,825,800,529.96	154,571,000,000.00
Statutory Allocation	14,241,169,928.84	5,269,268.79

Table 4.4.3 Descriptive Statistics of IGR, SA and GDP for 2001 to 2010

From table 4.4.2 it can be observed that the Statutory allocation rose from N7,145,256,943.00 in 2001 to N20,896,614,606.25 in 2010 which is about 200% increase in the aforementioned duration. Similarly, Internally Generated Revenue rose from N548, 431,150.00 in 2001 to N2, 454,450,646.20 in 2010. This is about 300% growth across the time frame under consideration. Furthermore it can be observed that Gross Domestic Product rose from

N353, 534,050,000.00 in 2001 to about N793,551,206,069.93 in 2010 representing a growth of about 120%. Internally Generated Revenue was almost the same from 2004 to 2006. However 2008 it jumped up to about 300% above the preceding year, but dropped by about 1billion yearly in 2009 and 2010. GDP from 2001 to 2010 has averagely increased year by year by about N40 Billion. In can be also be observed that in 2008 when Internally Generated Revenue jumped 3 times above the previous year statutory Allocation increased sharply by about N3Billion relative to other years. Generally, Statutory Allocation increased yearly by about N1Billion from 2001 to 2003 but in 2004 it increased by about N5Billion. The previous growth of about N1Billion was established from 2004 to 2007, jumping by upwards again in 2008 and dropping by N4Billion in each successive year from 2009 to 2010. See table 4.4.2 The Average of Internal Generated Revenue, statutory Allocation and Gross Domestic Product for the year 2001 to 2010 was N1, 668,304,518.78, N14,241,169,928.84and N569,825,800,529.96 respectively.

Table 4.4.8a

Model Summary ^ψ							
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics		
					R Square Change	F Change	Sig. F Change
1	.782 ^a	.611	.562	1.023E+011	.611	12.553	.008

a. Predictors: (Constant), IGR
b. Dependent Variable: GDP

Table 4.4.9b

ANOVA ^b						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1.3E+023	1	1.313E+023	12.553	.008 ^a
	Residual	8.4E+022	8	1.046E+022		
	Total	2.2E+023	9			

a. Predictors: (Constant), IGR
 b. Dependent Variable: GDP

Table 4.4.10c

Coefficients ^a						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	4E+011	6E+010		6.931	.000
	IGR	101.608	28.679	.782	3.543	.008

a. Dependent Variable: GDP

Correlation and multiple Regression analysis were conducted to examine the relationship between Internally Generated Revenue with (IGR) with GDP table 4.4.2 and 4.4.3 summaries the descriptive statistics and analysis result. It can be observed that the variable IGR has a strong positive correlation with GDP. Table 4.3a shows that regression model with its predictor variable produced $R^2 = 0.611$, $F(1, 8) = 12.553$, $p < 0.008$. As can be seen in table 4.4.4 IGR has Significant Positive relationship with a β weight of 0.782.

The coefficient (parameter estimate) of b_1 (0.782) is predicted, holding the other variable constant. The Strength of the relationship implied that for every unit increase in Statutory Allocation there will be a corresponding increase in GDP by about 0.782 units. This is significantly different from 0 and statistically significant.

Furthermore the explanatory power of R^2 measured with the goodness of fit of the regression model showed the explanatory power of the model. In the analysis the value of the coefficients of determination $R^2 = 0.611$ this is slightly above average. It implies that about 61.1% of the total variations in Gross Domestic Product are explained by internally generated Revenue alone .While the remaining 38.9% could however be attributed to the stochastic variable e which includes other variables not explained in the model.

From table 4.4.10 above, b_0 intercept when regression line crosses Y axis (Constant) is $4E + 011(40,031,319,753.00)$ when $X = 0$. Hence, the following equation result was obtained:

$$Y = 4E+011 + b_1 0.782 + (1.023E + 011).$$

The estimated coefficient model shows that, the estimate of model parameter is consistent with prior expectations for b_1

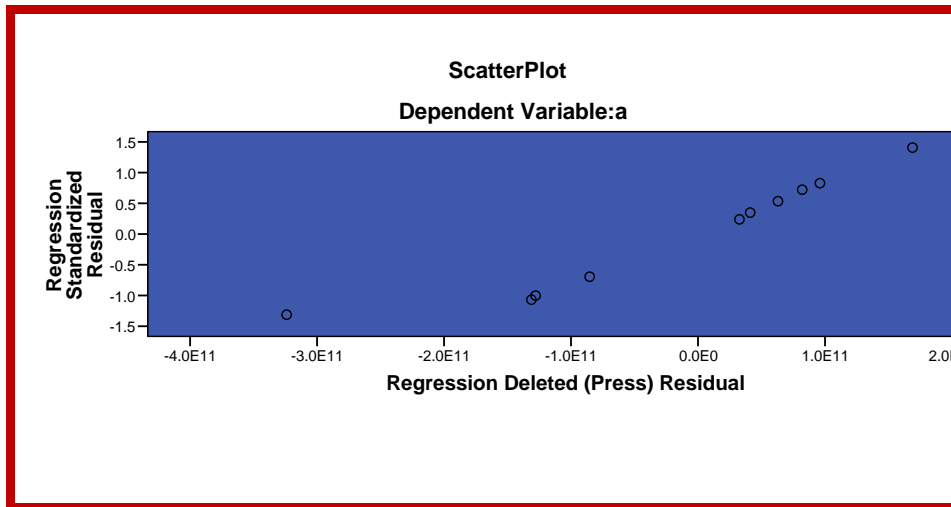


Figure 4.4.11 Relationships between GDP and IGR

Variable	From 2001 to 2010	
	\bar{X}	$\pm SD$
Internally Generated Revenue	1,668,304,518.78	1,188,866.66
Gross Domestic Product	569,825,800,529.96	154,571,000,000.00
Statutory Allocation	14,241,169,928.84	5,269,268.79

Table 4.4.12 Descriptive Statistics of IGR, SA and GDP for 2001 to 2010

From table 4.4.2 it can be observed that the Statutory allocation rose from N7,145,256,943.00 in 2001 to N20,896,614,606.25 in 2010 which is about 200% increase in the aforementioned duration. Similarly, Internally Generated Revenue rose from N548, 431,150.00 in 2001 to N2, 454,450,646.20 in 2010. This is about 300% growth across the time frame under consideration. Furthermore it can be observed that Gross Domestic Product rose from

N353, 534,050,000.00 in 2001 to about N793,551,206,069.93 in 2010 representing a growth of about 120%. Internally Generated Revenue was almost the same from 2004 to 2006. However, 2008 it jumped up to about 300% above the preceding year, but dropped by about 1billion yearly in 2009 and 2010. GDP from 2001 to 2010 has averagely increased year by year by about N40 Billion. In can be also be observed that in 2008 when Internally Generated Revenue jumped 3 times above the previous year statutory Allocation increased sharply by about N3Billion relative to other years. Generally, Statutory Allocation increased yearly by about N1Billion from 2001 to 2003 but in 2004 it increased by about N5Billion. The previous growth of about N1Billion was established from 2004 to 2007, jumping by upwards again in 2008 and dropping by N4Billion in each successive year from 2009 to 2010. See table 4.4.2. The Average of Internal Generated Revenue, statutory Allocation and Gross Domestic Product for the year 2001 to 2010 was N1, 668,304,518.78, N14,241,169,928.84 and N569,825,800,529.96 respectively.

Table 4.4.13

Model Summary ^ψ						
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics	
					R Square Change	F Change
1	.952 ^a	.907	.880	53590335524.476	.907	33.936

a. Predictors: (Constant), IGR, SA
 b. Dependent Variable: GDP

Table 4.4.14

ANOVA ^ψ						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1.9E+023	2	9.746E+022	33.936	.000 ^a
	Residual	2.0E+022	7	2.872E+021		
	Total	2.2E+023	9			

a. Predictors: (Constant), IGR, SA
 b. Dependent Variable: GDP

Table 4.4.15

Coefficients ^a						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2E+011	6E+010		3.212	.015
	SA	26.498	5.631	.903	4.706	.002
	IGR	7.833	24.958	.060	.314	.763

a. Dependent Variable: GDP

Correlation and multiple Regression analysis were conducted to examine the relationship between Statutory Allocation (SA) and IGR with GDP table 4.4.3 and 4.4.4 summaries the descriptive statistics and analysis result. It can be observed that the variables SA and IGR are jointly having a positive correlation with GDP. Table 4.4.13 shows the multiple regression model with all two predictors produced $R^2 = 0.907$, $F(2, 7) = 33.936$, $p < 0.000$. As can be seen in table 4.4.4 Statutory Allocation (SA) has Significant Positive relationship with GDP while Internally Generated Revenue did not contribute to the model.

The coefficient (parameter estimate) of b_1 (0.903) and b_2 (0.060), is predicted, holding the other variable constant. Only Statutory Allocation has a significant positive regression weights with Gross Domestic Product implying that for every unit increase in Statutory Allocation there will be a corresponding increase in GDP by about 0.903 units. This is significantly different from 0 and statistically significant.

Furthermore the explanatory power of R^2 measured with the goodness of fit of the regression model showed the explanatory power of the model. In the analysis the value of the coefficients of

determination $R^2 = 0.907$ is high. It implies that about 90.7% of the total variations in Gross Domestic Product are explained by Statutory Allocation and Internally Generated Revenue (Although IGR contribution is insignificant). While the remaining 9.3% could however be attributed to the stochastic variable e which includes other variables not explained in the model. From table 4.3c above, b_0 intercept when regression line crosses Y axis (Constant) is $2E + 011(179,394,745,980.60)$ when $X = 0$. Hence, the following equation result was obtained: $Y = 2E+011 + b_1 0.903 + b_2 0.060 + (5.359E + 010)$.

The estimated coefficient model shows that, the estimate of model parameter is consistent with prior expectations for b_1 and b_2

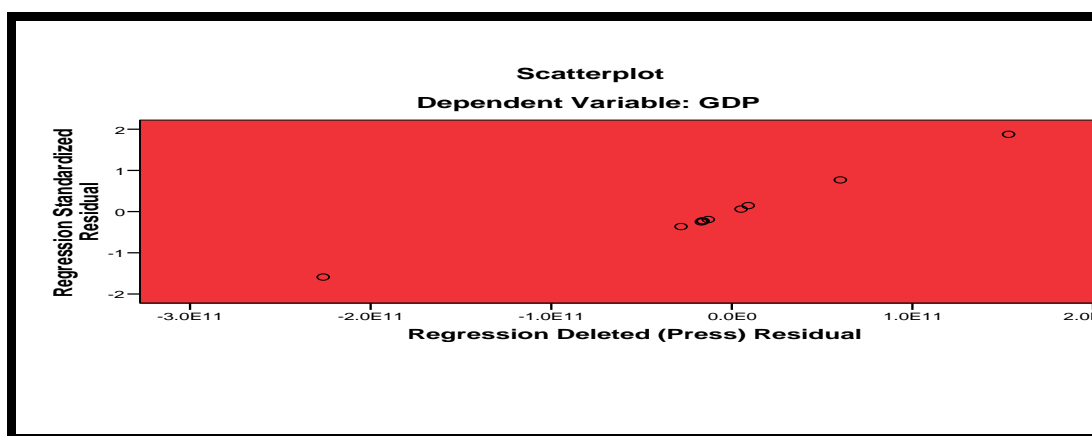


Figure 4.4.16 Relationships between GDP and (SA) and IGR

The study brought out following issues to the fore:

1. Statutory Allocation (SA) and Internally Generated Revenue (IGR) contributed to Economic Development. However, the needs to do more in boosting internally generated revenue.
2. The study reveals that Ekiti State encounters some problems and challenges in collecting internal revenue tax evasion, falsification of documents, ignorance of the importance of taxation, poverty, negative attitudes of the public to tax, improper or inefficient utilization of collected taxes and inadequate qualified personnel to execute tax policies. This finding is consonance with the earlier position of Akintoye and Tashie (2013) when they assert that ineffective revenue generation can be attributed to a number reasons including the system of taxation; tax legislation; tax administration and policy issues; over reliance on other sources of revenue (such as foreign aid and grants); corrupt practices in the system – especially as it relates to the system of tax collection and behaviour of citizens towards tax payment; and ease of tax payment.
3. The study shows that Ekiti State has not generated significant revenue from tourism in spite of at least six (6) tourist locations within the state. The state did not meet her IGR budget during the period under review (2001 to 2010). Meanwhile, the state has the potential to grow her IGR provided the challenges of revenue generation are addressed.

Conclusion and Recommendations.

The results show that the variables Statutory Allocation (SA) and Internally Generated Revenue (IGR) are jointly having a positive correlation with Gross Domestic Product. However, only Statutory Allocation has a significant positive regression weights with Gross Domestic Product

implying that for every unit increase in Statutory Allocation there will be a corresponding increase in GDP by about 0.903 units. Therefore, the state needs to boost Internally Generated Revenue.

Ekiti State should widen the net of IGR probably not only in tax but other sources e.g mineral deposits like Clay Kaolin in IsanEkiti, Cassiterite, Tin Ore and Columbite at IjeroEkiti, Feldspar mining site in EfonAlaye, Caolin Site at Aramoko, Charnochite Granite in various locations, etc.

The State Government should equally address problems militating against growing IGR like tax evasion, falsification of documents, ignorance of the importance of taxation, poverty, negative attitudes of the public to tax, improper or inefficient utilization of collected taxes inadequate qualified personnel to execute tax policies, etc.

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Political Choice/Preference and Its Relationship with Prejudice Evaluations

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Abstract

Relationship between political choice/ preference from a list of six (6) political parties and prejudice towards various groups religious, gender, nationalities was studied in the study. A questionnaire was administered to randomly selected 1000 subjects asking about their political choice/ preference and then to select from evaluations based on prejudice towards Jews/ Judaism, Hindus/ Hinduism/ Christians/ Christianity/ Muslims/ Islam Pakistan/ Pro Pakistan behavior/ and Jamaat-e-Ahmadiya. After the completion of all questionnaires the lowest number of choices for a party was counted that was 50 than using the technique of odd even an equal number of all filled questionnaires 50 each for each party were shorted out for analysis each response was assessed in two dimensions high and low prejudice, the Chi Square results reflect that political choice/ preference of the subjects and their evaluations of prejudice towards gender, nationalities and religion are significantly related

Key words; Political Choice/ Preference, Prejudice

Introduction

The historical records about prejudice studies (Samelson 1978) and recent report about prejudice (Dominic 2010) reflect how it is related with the individual as well as with the group (Dicks1959) and can affect human groups in various forms like 'malign antipathy', 'rivalrous cohesion', 'benign indifference' (Dominic 2010).and religion (Gregory1987), religious practices (Allport,;Ross, 1967), religious attitudes (Rabbi) how it is related with 'harmonious society' (JIA 2010) quality of life (Wang,Zheng,Zhou 2008) and policies (Melton1989) conventional values (Lee, Guo 2003) moral and political views (Michael 2000)political parties (Margaret 1985) human automatic and control processes (Devine1989) acquisition of power (Sue, Stanley 1983)however still various questions about prejudice are unanswered (Duckitt1992) and different strategies are possible to answer such questions (Dominic 2010) Moreover the socio political influence of prejudice have also been reported (Abrams and Emler1992)

Political behavior and power motive assumed to be associated and 'power orientations' influence human behavior (Galinsky, Gruenfeld and Magee 2003) whereas, people possess the ability to assess the out groups as a 'different essence' (Leyens et al 2001) and political power is not situational so it can influence more automatic racial attitudes as compared with situational power (Richeson, and Ambady, 2001) moreover, powerful people relay on 'subjective experiences' more while deciding (Weick 2008) so group orientations of power group in some cases can be more influential towards out group members than the real or symbolic or realistic threats (Walter et al1998). According to 2011 ranking 25 countries of the world are enjoying full democracies whereas 54 countries are having flawed democracies. That means the peoples of 79 countries of the world in one way or the other depend on majority political groups and such political groups or say political parties influence the peoples of 79 countries through vote as a result of democratic political process so if the behavior of political preference or choice in any manner is related with some kind of prejudice than it deserves the importance to be studied.

The present study has been designed to find that whether there is any relationship between prejudice and political party choice/preference and if so than whether this relationship between given political party and prejudice confines itself to the political party related matters only or manifests itself in larger generalized context?

Method

A questionnaire consisting of questions about political choice 'choose the party from a given list you like the most' and direct questions related with prejudice about various groups religious, gender, nationalities (Jews/ Judaism, Hindus/ Hinduism/ Christians/ Christianity/ Muslims/ Islam Pakistan/ Pro Pakistan behavior/ Jamaat-e-Ahmadia) was developed

Initial Sample

The sample for the study was taken from 1000 (One thousand) randomly selected subjects belonging to various professions low paid and highly paid, not educated and highly educated and working or non working. The subjects were asked to choose a political party as their top choice from a given list of registered political parties those were the member of the parliament or were popular in the area the list include 6 (six) political parties those renamed as PS,SJ,AS,QS,MS,NS. After the selection of political choice the subjects were asked to rank the prejudice of the top leaders of the parties of their choices towards different groups religious, gender and nationalities

Sample

After the completion of all questionnaires 1000 the lowest number of choices for a party was counted that was 50 than using the technique of odd even an equal number of filled questionnaires 50 each for each party total 300 subjects sample was shorted out from 1000 questionnaires for the response analysis of the responses of subjects about prejudice.

Procedure

Each response of the subject was assessed in two dimensions high and low prejudice total 2100 responses of the subjects Table (A) were analyzed after the tabulation of analysis the significance of the responses was determined with Chi Square test by grouping 6 parties into three groups of two parties each. The calculation later evaluated on.02 Alpha and df; I.

Table A: Party wise Prejudice High Low Responses

Question No.	Jews/Judaism		Hindu/ Hinduism		Christians/ Christianity		Muslims	
	Q	1	Q	2	Q	3	Q	4
Party Name	High Prejudices Responses	Low Prejudices Response	High Prejudices Responses	Low Prejudices Response	High Prejudices Responses	Low Prejudices Response	High Prejudices Responses	Low Prejudices Response
PS	45	5	17	33	17	33	25	25
SJ	24	26	28	22	31	19	25	25
AS	32	18	26	24	23	27	35	15
QS	35	15	26	24	23	27	17	33
MS	22	28	33	17	28	22	34	16
NS	24	26	20	30	32	18	30	20
	Pakistan		Women		Jamaat-e-Ahmedia			

Question No.	Q	5	Q	6	Q	7
Party Name	High Prejudices Responses	Low Prejudices Response	High Prejudices Responses	Low Prejudices Response	High Prejudices Responses	Low Prejudices Response
PS	30	20	18	32	15	35
SJ	40	10	19	31	23	27
AS	40	10	33	17	20	30
QS	24	26	25	25	32	18
MS	12	38	35	15	32	18
NS	22	28	16	34	22	28

Results

The Chi Square of PS and SJ is 3.022, AS and QS is 4.22 MS and NS is 5.14

Conclusion

Since the values of Chi Square fall in the critical region therefore the null hypothesis is rejected and it is concluded that political choice/ preference of the subjects and their evaluations based on prejudice towards gender, nationalities and religion are significantly related and political choice/ preference influences the prejudice outlook of subjects.

Discussion/ Recommendations

Further research in the area is proposed for beneficial utility of. political choice / political preference and it social influence such can contribute to predict certain social features in case of certain political choice / political preference .

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Solid waste collection and management practices among community residents in varying population density areas in Ibadan, South West Nigeria

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Abstract

This paper presents the results of a study conducted in four socio-economic (three urban low-, medium- and high-density residential communities and one rural) areas of Ibadan. The study assessed the amount and nature of solid waste generated, the level and benefits of community participation in source separation and recycling potential and the factors responsible for poor solid waste management in the city. The study is cross sectional in design involving 153 households. A questionnaire survey and waste assessment were carried out in the selected households. Waste assessment included volume, weights and various segregated waste components over a period of seven days in the week. The waste generated (kg/c/day) was the highest in low density area (0.688) followed by rural (0.636), high density (0.452) and medium density area (0.303). The mean generation rate was 0.52 Kg/c/day. The recyclable dry waste was more than the wet waste. About 71.7% of the respondents were aware of and segregated some recyclables from the wastes and only 9.2% tried to convert wet waste into compost. The reasons for non-practice of source separation of waste at household level were bad odour, lack of capital, fear of disease-causing germs, pollution of surroundings, and need for much labour and time. The study suggested creation of more awareness along with demonstration/practice of waste assessment, regular segregation and recycling activities involving stakeholders in the communities.

Key Words: Solid Waste Management, Residential Density, Communities, Recycling, Compost

Introduction

The menace of municipal waste and its associated management problems in Nigerian cities are well documented (Sridhar and Ojediran 1983, Akpovi and Sridhar 1984, Sridhar et al 1985, Egunjobi 1986, Afon 2006, Nabegu 2010). The most enduring of all the urbanization – induced problems in the country is waste problem (Agbola and Jinadu 2006) and the problem is more pronounced in Ibadan, as heaps of garbage are seen in most parts of the expanding city particularly the high density core areas, road sides open spaces and drains (Adeniji and Ogundijo 2009). Historically, from 1960 to date, the assessment studies on waste types and generation were based on the needs of the ruling government with a view of pushing the problem to dump site management. The waste generations then varied from 0.37 to 0.53kg/c/day and 3.2 to 3.4 kg/household/day (Maclaren 1970, PAI Associates International 1982, Oluwande 1983, Egunjobi 1986).

Subsequently, a study conducted by Haskoning and Konsadem Associates (1994) revealed a per capita generation rate of 0.6kg/day with a density of 300kg/m³. The city currently generates 0.52kg/capita/day of solid wastes with a density of 330kg/m³. The waste collection rate in Ibadan currently stands at 10% (OYSWMA 2012). For an effective and sustainable management of solid waste, an important factor that was not given priority was the quantity of waste generated in various residential densities and the involvement of communities. This paper, therefore, addresses an update on the types and quantity of waste generated across varying residential density zones of Ibadan city with a population size of over 3.5 million and the benefits derivable from community involvement in source separation and recycling.

Waste governance is the conceptual framework for this paper. The European Commission developed and implemented the concept to address waste management problems in Azerbaijan, Georgia, Armenia, Belarus and Ukraine. The concept looks at waste governance from five different perspectives: partnership; ensuring transparency in decision making; information systems/use of indicators; relationship between different levels of authority; and financing (EC 2012).

Materials and methods

Study Locations

Ibadan, the capital of Oyo State, is located in the South Western part of Nigeria at an altitude generally ranging from 152 to 213m, with isolated ridges and peaks rising to 274m. The Ibadan Metropolis has 11 Local Government Areas (LGAs) of which 6 are inner city and 5 are peripheral to the city. Its projected population by 2010 using 3.2% growth rate was about 2,893,137 (Wahab 2011) and 3,191,339 by 2013 (Agbola 2013). During the 1980s and 1990s, the spatial growth of the city began to sprawl into the country side in the South and South East of the city that is Akanran – Ijebu Ode Road such that areas that were previously villages have now been engulfed by the city. Ashi, Aare and Ajibode are some examples. By 2006 the city covered a total area of 3,080 Km² giving a metropolitan density of 250/km² and regional density of 828/km² (http://en.m.wikipedia.org/wiki/Oyo_State). The satellite image of the city obtained from LandSAT 2013 in December, 2013 showed that the city has expanded to 5,388.3 km² (Taiwo, 2013). In 2003, high density residential landuse covered 86.81²km, low density 115.05² km, medium density 98.39sqkm (Fabiya, 2006).

There are three major residential density areas well demarcated in the city consisting of high-density development (200 persons per hectare) in the inner core of the city surrounded by medium density (120 persons per hectare), and low-density residential zone (60 persons per hectare) majorly the GRAs and public housing estates. found at the outskirts. Approximately 70 per cent of the inhabitants live on an annual income of less than Nigerian Naira, NGN 2,000 (1USD=NGN 170).

Methodology

The study was conducted in 4 areas, three urban and one rural. The three urban areas fall within Ibadan South West LGA and have a population of 283,098 (NPC 2006). These areas were selected based on the population stratification: high, medium and low density. They include:

a) Oke-Foko (high density): It consists of 12 zones and has an estimated population of 36,225. While a majority of women engage in trading, men are engaged in tailoring, automobile mechanics, welding and carpentry and small scale businesses such as plastic and metal recycling. The community depends mostly on any available water source and sanitation is poor as there are only a few toilets which are either public or pay and use type.

b) NTC (medium density): This area consists of 12 zones. Population figures were not available as it is a part carved out of Iyaganku GRA area. People engage in occupations such as trading, artisan activities and civil service. The water supply is from shallow wells and most of them use pit toilets.

c) Iyaganku GRA (low density): This is a government reserved area and the residents belong to high socio-economic group. It has a projected population of 8,377 of which only 2,681 people are currently resident whereas others reside occasionally. Most of the residents own private water supply like boreholes and enjoy individual toilets.

d) Ayegoro/Oyawo village (a rural area): This location was selected from Ido LGA on the periphery of the metropolitan city. Majority of people are engaged in farming, petty trading and small-scale business, while some are into civil service.

Sampling

Google Earth Map was used to count the number of houses in delineated survey areas and verified physically. Survey took place in Wards 5, 6 and part of 7 with a total of 1940 houses in Oke-Foko, 12 neighbourhoods (with a total of 543 houses) in NTC, and Iyaganku with 873 houses. The Ayegoro/Oyawo, had a total of 20 houses. Random sampling method was used to select houses in each area and one household was sampled from each of the selected houses in the following manner:

(a) Urban

Oke-Foko community -- 97 houses (5% of 1940) = 97 households sampled.

NTC-Oke Ado community -- 27 houses (3.1% of 864) = 27 households sampled.

Iyaganku GRA – 20 houses (2.3% of 873) = 20 households sampled.

(b) Rural

Ayegoro/Oyawo village -- 9 houses (45% of 20) = 9 households sampled.

The heads of the households or any available senior person were involved in the administration of questionnaire. Waste was assessed from every house sampled for seven days of the week to obtain the daily variations.

Study Instruments

The study used questionnaire survey involving the selected community members, and waste assessment from the selected households through measurement of volume, weights and various components through segregation.

(i) Questionnaire administration

The 27-item questionnaire was designed to address households' demographic characteristics, waste generation pattern, the knowledge, attitude and perceptions as well as perceived ideas and practices on waste minimization, recycling and segregation.

(ii) Waste Assessment

The waste generated in the sampled households was assessed for 7 days in the week Monday through Sunday with a view of finding the generation pattern, rate and the predominant components (biodegradable and non-biodegradable). Colour coded bags, viz. black plasticfilm bags (200 kg capacity for wet waste) and white jute bags (50 kg capacity used sacks for dry waste) were labeled with the house number and the day of the waste collected in the week. For example, a sample bag reads: House 2, Day 1 (this was done up to Day 7 to complete the week). Therefore, in a day, a house had one black and one white bag for collecting their wastes. At the end of each day, the bags were tied up and kept for collection. The designated Field Assistants (FAs) then went round and collected these bags. Trucks from the Oyo State Waste Management Authority (OYSWMA) were used to collect the bags with the wastes and then transferred to a central place, Pace-Setter Fertilizer Plant site in Bodija market for sorting and assessment.

For convenience and cost saving, wastes were collected every alternate day totaling three times in the week. The waste collection and clearance schedules for the four study areas were as follows: Saturday and Sunday generated wastes were picked up on Monday; Monday and Tuesday generated wastes were picked up on Wednesday; and Wednesday, Thursday and Friday generated wastes were picked up on Saturday. Sunday was a work-free day. The waste collected in each bag for a day was weighed using a sensitive balance and recorded on a data sheet specially designed. Then the non-biodegradable wastes were separated into different components – metal, glass, plastics etc., weighed and recorded. The mean weight of the wastes for each household was obtained. Adequate personal protective equipment (PPE) such as gloves, nose mask, apron and gum boots were given to all FAs. Community entry was carried out by the research team as per the procedure. Important leaders and members in the different communities were met and the project content was explained.

Results and discussion

Demographic Characteristics of the Communities

The gender distribution of the respondents in the communities indicates that in high density area female respondents were more in number and in medium and low density areas male respondents were more. In the rural area also, men were more in answering the questions (Table 1). Culturally, men as head of families play significant roles in household decisions. Considering the family size of the respondents, in Oke-Foko (high density area), the mean family size was 3-6 members among 46.4% of the respondents. About 24.7% of them had less than 3 members. The family size of 7-10 was also found particularly in low and medium density areas. The same trend was observed in medium and high density areas and the rural (Table 1). Family size influences the amount of waste generated. In the high density area, 43.8% lived in rented houses whereas 40.6% had inherited theirs. In the medium density area, 50% owned their houses followed by 36.1% who rented. In the low density, 94.4% owned their houses. Typical of rural, 75% of the respondents owned their houses. The rents ranged from NGN 500 to NGN 8700 per month. In high density area about 48.8% paid a rent of NGN 600 per month. In the medium density area, 25% rented their houses in the range of NGN 1000 – 2000 per month. Furthermore, in high density area 43.3% lived for over 20 years and 53.8% in NTC-Oke Ado were indigenous and lived for over 20 years. However, in Iyaganku GRA, many had moved to other places or out of the country or rent their houses for others. These people occupied the houses for over 3-6 years. In the rural area, 66.6% were resident for over 20 years (Figure 1). Occupations varied in each of the locations. In Oke-Foko 51.5% were traders followed by teaching and civil service. In NTC-Oke Ado, 29.6% were in civil service followed by trading and other miscellaneous occupations. Students were also found living in this area. In Iyaganku GRA, civil service and trading were predominant occupations. In the rural area, farming (55.6%) and trading (22.2%) were predominant (Figure 2).

Table 1: Demographic Characteristics of the Respondents

Gender	Oke-Foko	NTC Ado	Oke-Iyaganku	Ayegoro-Oyawo	Total
Male	42	20	12	9	83
% within gender	50.6	24.1	14.5	10.8	100.0
% within location	43.3	74.1	60.0	100.0	54.2
Female	55	7	8	0	70
% within gender	78.6	10.0	11.4	0	100.0
% within location	56.7	25.9	40.0	0	45.8
Total	97	27	20	9	153
% within gender	63.4	17.6	13.1	5.9	100.0
% within location	100.0	100.0	100.0	100.0	100.0

Family Size of Respondents

Less than 3	24	0	3	2	29
% within gender	82.8	0	10.3	6.9	100.0
% within location	24.7	0	15.0	22.2	100.0
3 – 6	45	13	10	6	74
% within gender	60.8	17.6	13.5	8.1	100.0
% within location	46.4	48.1	52.6	66.7	48.4
7 – 10	22	12	7	1	42
% within gender	52.4	28.6	16.7	2.4	100.0
% within location	22.7	44.6	36.8	11.1	27.5
Greater than 10	6	2	0	0	8
% within gender	75.0	25.0	0	0	100.0
% within location	6.2	7.4	0	0	5.3
Total	97	27	20	9	153
% within gender	63.8	17.8	12.5	5.9	100.0
% within location	100.0	100.0	100.0	100.0	100.0

The mean family sizes of the communities are- Oke-Foko 5.66, NTC-Oke Ado 7.19, Iyaganku GRA 6.05, and Ayegoro/Oyawo 4.89.

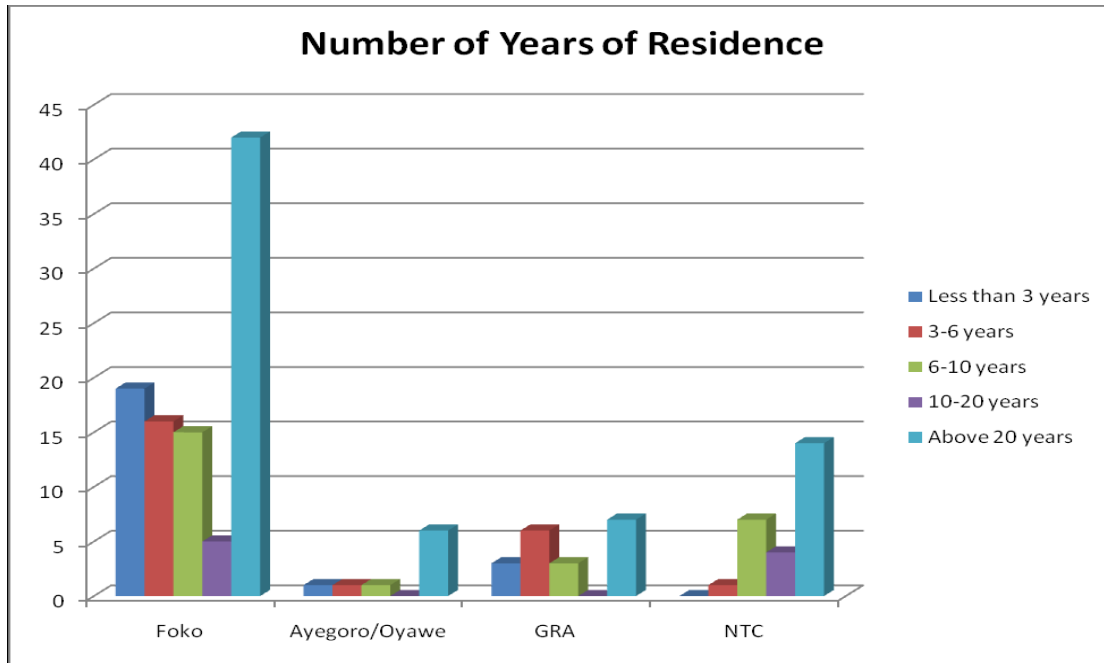


Figure 1: Number of years of residence by the respondents

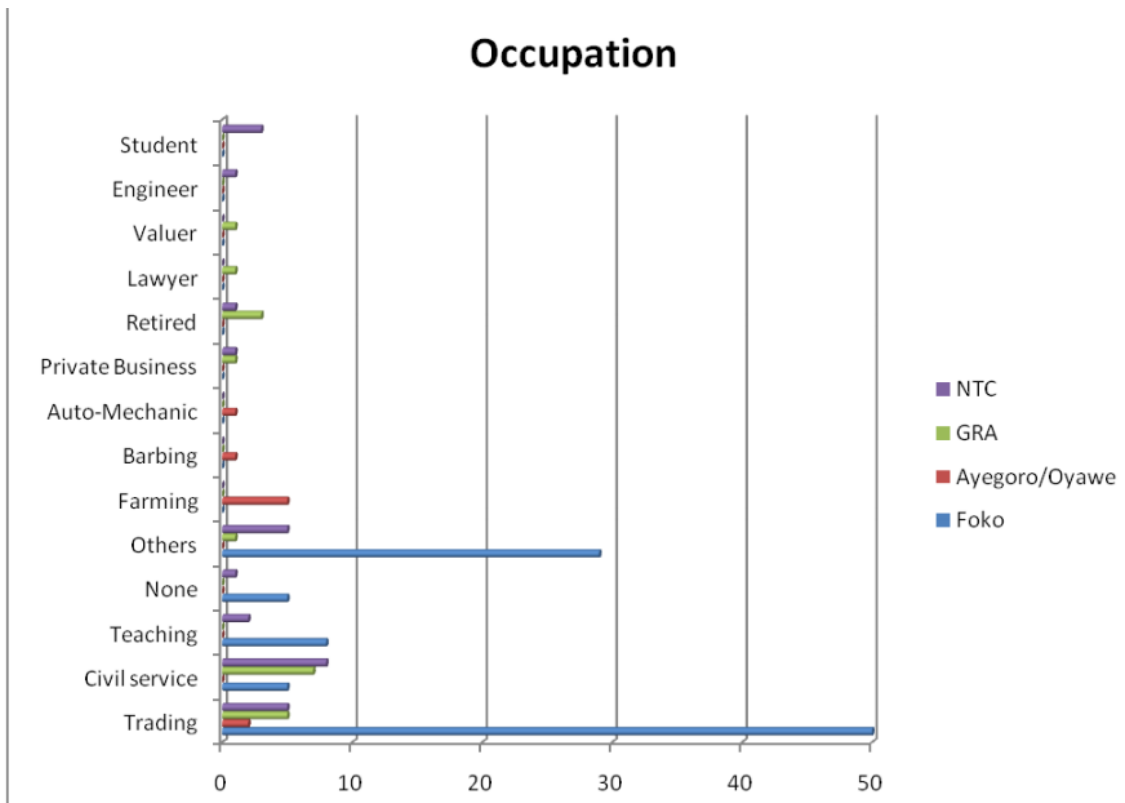


Figure 2: Major occupations of the respondents

Waste Generation and Composition

Waste generation trends in the study communities

The results (Table 2) indicate that the waste generation varied with the day of the week. In the high density area, the least generation was on Sunday while in the medium density, Friday, and in

the low density area, Wednesday. In the rural area, the least was on Monday. The total waste generated in each community projected for 1000 population is in the order: rural (Ayegoro-Oyawo) > low density area (Iyaganku GRA) > high density area (Oke-Foko) > medium density area (NTC-Oke Ado). The increase in the waste observed in the rural and low income communities is possibly from farm activities as the people bring their farm produce to residential areas for processing. It is also to be noted that there is a growing trend in urban areas to have at least one meal outside the house every day for the employed. Fast food restaurants, more and more use of packaged water for drinking, engagement of private sector in disposing some of the recyclables have considerably changed the composition and quantity of wastes generated. The picture of total waste generated also showed more waste in the low density areas. The waste generation in rural area is also dependent on the farm produce brought home unprocessed and in some of the houses there was more of wet waste in the form of maize cobs or cassava peels etc.

Table 2: Daily generation of total waste in each community (in Kg) Week Day

	Oke-Foko n=515 (97)	NTC-Oke Ado n=194 (27)	Iyaganku GRA n=127 (21)	Ayegoro/Oyawo n=44 (9)
Saturday	257.20	57.11	94.56	21.17
Sunday	203.20	49.95	43.35	24.26
Monday	306.62	61.19	45.13	24.58
Tuesday	200.81	75.43	77.97	25.89
Wednesday	282.28	41.98	80.00	31.19
Thursday	215.41	48.77	108.51	26.30
Friday	271.27	77.88	104.22	42.61
Week Total	173.68	412.31	553.73	196.01
Projection for 1000 population, Kg per week	3372.38	2125.29	4360.05	4454.71

Dry vs. Wet Waste Generation

The results on the proportion of dry (recyclables) vs. wet (biodegradable) wastes in the communities are shown in Figure 3. All the communities produced more recyclable dry waste than the wet waste. The rural (Ayegoro/Oyawo) and low density Iyaganku GRA communities produced highest amounts. It is to be noted that there is a change in the cooking and eating behavior of middle income communities. Significantly less wet waste was produced in the medium density area which is indicative of changing lifestyle as most of the employed took at least one meal a working day outside the house. Women were mostly traders or in business and they also ate at their workplace. When projected to 1000 population in each community, the low density high income area generated the highest quantity of wet waste reflecting their lifestyle.

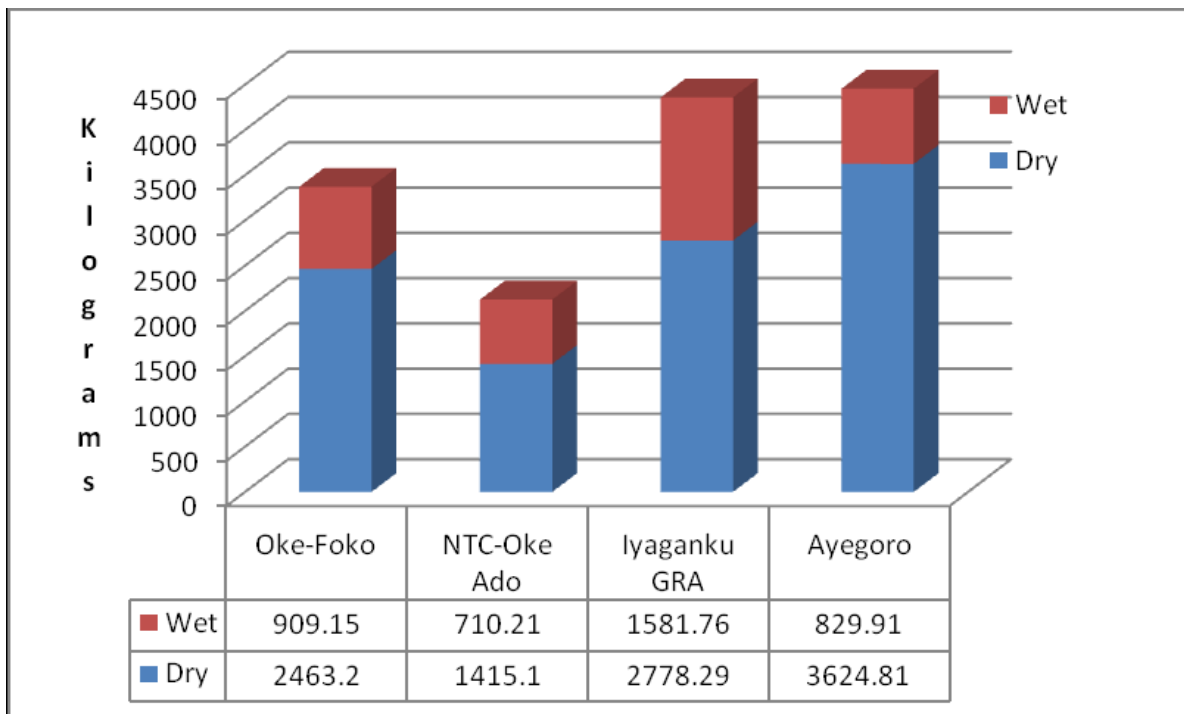


Figure 3: Proportion of dry and wet wastes in the communities (Projected for 1000 population in each community)

Daily variations in the wastes generated

The results in Table 2 indicate that day to day variations with extremes were more common in high density area. Waste generation was more on Mondays and less on Tuesdays. In low density area, the waste was less on Sunday and Monday but progressively increased until the week end. However, in the medium density and rural areas the generation was steady.

Waste Composition

The various components in the wastes are shown in Figure 4. Leaves, plastic film/nylon, rubber/shoes, textiles, glass (coloured) dominated the wastes. White glass is relatively low as it has an immediate resale value and rarely gets to the dustbin. The plastic found in the communities was mostly the thin plastic film type originating from the packaged water sachets. Metal scrap was also more in high-and medium density areas. One feature of the low density area is that most of the recyclables would be taken away by the domestic maids working in the houses for resale. Leaves were found in high amounts in rural community as most of these were from farms and the trees surrounding their houses. Similarly, the low density area, had relatively high amount of leaves as the area is characterized by trees and shrubs. Ash is only found in the high- and medium density areas indicating that these communities still used firewood, charcoal and kerosene (when available) for their cooking needs as they could not afford high cost of gas and other alternatives. Ash in the rural area is not collected in the waste as the households usually dispose off on the backyard or save it to make local soap.

Cow dung was only found in the high density area where the households kept cows for a few days before slaughtering. Poultry waste was found, however, in high density and low density areas as the households usually kept them for family consumption and occasionally for a little extra income.

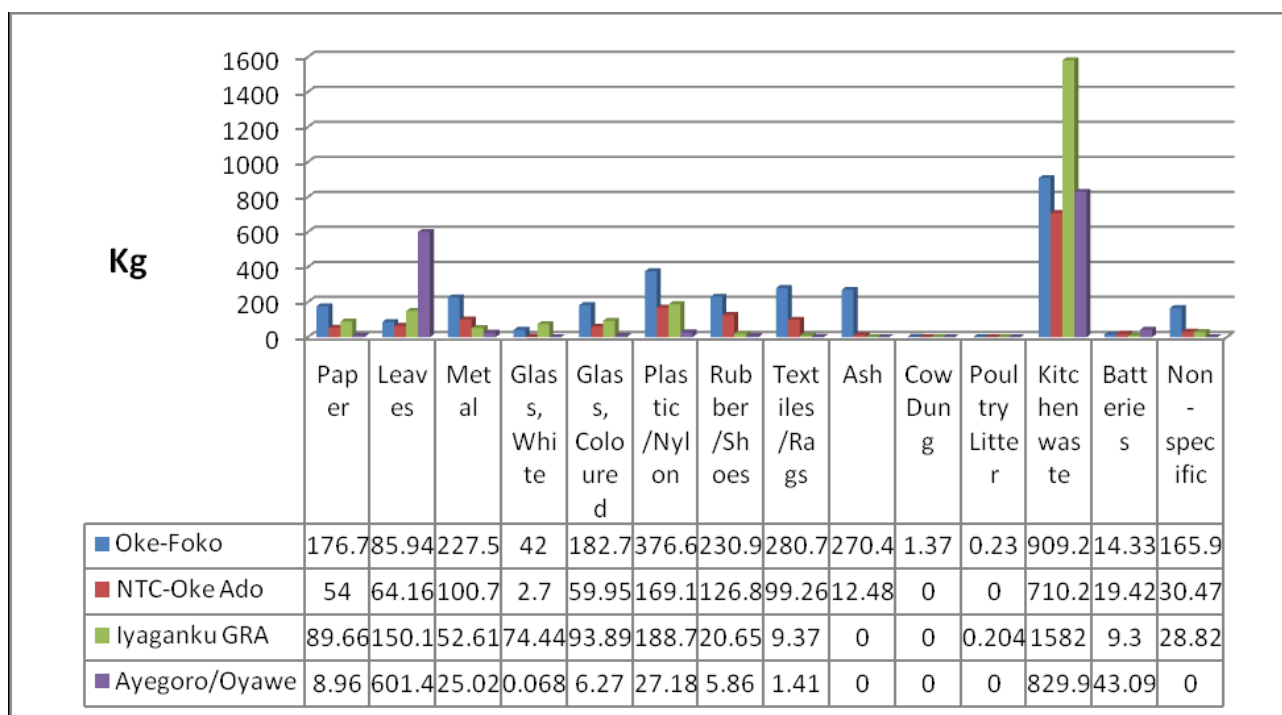


Figure 4: Various components in the wastes generated weekly by the communities (per 1000 population projected in each community).

Batteries were more commonly used in the rural area and high and medium density areas as there was shortage of electricity and most of them used radios, torch lights and other appliances run on batteries. The batteries were not segregated and, therefore, entered the main waste stream.

Per capita generation of waste in the communities

Based on the data collected, per capita generation of waste is calculated in each of the communities. When viewed from community density perspective, the low density area produced the highest amount of 0.688 kg/c/day followed by rural 0.636, high density area 0.452 and medium density area 0.303. The total mean generation rate is 0.52 Kg/c/day. From the data, it is evident that there is no much change from the earlier reported rates. The variations seem to be the various components such as increased plastic/nylon, and some of the recyclables which were not very conspicuous in the past. The low amounts recorded in the medium density area was due to changing lifestyle of fast urbanization with increased fast food outlets, nature of job and keeping rural houses by the urban dwellers which they frequented during the weekends and holidays.

Projections of waste generation

Projected amount of waste generated in the LGAs

Based on the data from the sampled communities, a projection has been made to the city of Ibadan (with 11 LGAs) with 2006 population figures released by the National Population Commission. The results are given in Tables 3 and 4. The mean generation rate of 0.52Kg per capita per day is used for the projection. From this, the expected waste generated is 485,861 Tons per annum in 2009 and 544,164,031 Tons per annum in 2013 thereby showing considerable increase.

Table 3: Projected amount of waste generated in the city of Ibadan by LGAs (2009)

LGA	Population	Waste generated Per day Kg	Waste generated Per annum Kg	Remarks (Rank by volume generated)
Ibadan North East	331,444	172350.88	62908071.2	1
Ibadan North	308,119	160221.88	58480986.2	2
Ibadan North West	154,029	80095.08	29234704.2	9
Ibadan South East	266,457	138557.64	50573538.6	5
Ibadan South West	283,098	147210.96	53732000.4	4
Ido	104,087	54125.24	19755712.6	11
Lagelu	148,133	77029.16	28115643.4	10
Oluyole	203,461	105799.72	38616897.8	8
Ona-Ara	265,571	138096.92	50405375.8	6
Akinyele	211,811	110141.72	40201727.8	7
Egbeda	283,643	147494.36	53835441.4	3
Total	2,559,853	1,331,124	485,860,260	

Table 4: Projected amount of waste generated in the city of Ibadan by LGAs (2013)

LGA	Population	Waste generated Per day Kg	Waste generated Per annum Kg	Remarks (Rank by volume generated)
Ibadan North East	371217	193032.84	70457045	1
Ibadan North	345093	179448.36	65498651.4	2
Ibadan North West	172513	89706.76	32742967.4	9
Ibadan South East	298432	155186.64	56643123.6	5
Ibadan South West	317070	164876.40	60179886	4
Ido	116577	60620.04	22126314.6	11
Lagelu	165909	86272.68	31489528.2	10
Oluyole	227876	118495.52	43250864.8	8
Ona-Ara	297440	154668.80	56454112	6
Akinyele	237228	123358.56	45025874.4	7
Egbeda	317680	165193.60	60295664	3
Total	2,867,035	1,490,860	544,164,031	

Waste management practices in the communities

Waste collection and disposal

This section assessed some of the practices of the respondents with regard to the handling of the wastes, such as collection, segregation, knowledge of the recyclables and recyclables, modes of disposal and any perceived economic or health problems they faced during the practice. Since the sample size is small, they were combined together so as to obtain a general trend.

Container used for waste collection and frequency of collection

A majority of the respondents used baskets (46.7%) for collecting their wastes followed by standard dustbin (21.1%) and empty cartons (20.4%). Still 2.0% threw outside and 7.2% used anything available. About 63.3% of the respondents collected the wastes daily, 16.0% collected once a week and 11.3% twice in a week. Only 6.6% collected every alternate day and 2.0% once in two weeks.

Collection practices for disposal

The wastes generated from the houses were collected by female child (30.0%), male child (26.0%), mother (25.3%) or a maid (16.0%). In some 2.7% of the houses, any one from the house may collect. For final collection of the wastes for disposal, 20.0% engaged contractors, 18.0% engaged the services of the OYSWMA. About 5.3% threw wastes into nearby drainage, 6.7% burned and 2.6% threw into the bush. A very significant 40.7% of the respondents claimed "others" which is vague and we are tempted to feel that their wastes go into the surroundings unchecked. Some people also claimed that they used their cars to dispose their wastes which are apparently going into the bush or roadsides and drains. Some people claimed that they paid from N1000 to N2000 monthly to the private contractors and this depends on the number of containers and frequency of collection. The maximum amount paid was reported to be N3500 per month. Those who did not engage contractors, which accounted for 79.5% of the respondents, disposed of their wastes by various unhygienic means e.g. open dump, stream, open burning, bush and roadside.

Waste utilization

Recycling as one of the sustainable ways of managing solid waste has been variously advocated. Waste recycling facilitates waste reduction as well as income and employment generation. Thus, the survey sought to determine the knowledge and attitudes of the residents on waste recycling. About 71.7% of the respondents knew that there are some components in the wastes which have value if removed. About 94.0% of the respondents did not bother to collect and sell such recyclable materials from the waste while some 6.0% sold recyclables to scavengers. All the respondents except 1.3% reported that they did not throw faeces into the waste kept for collection thus making the recycling acceptable from health point of view. If given an opportunity, 73.2% of the respondents would like to keep the recyclables separate for sale. About 35.3% of the respondents knew some communities or people around who segregated the recyclables and sold them to scavengers. Only 9.2% of the respondents tried to convert wet waste into compost. Only 24.3% had some land for any recycling activities. Some 78.0% were willing to start segregation and recycling activities and 80.0% were ready to influence their friends in the community to embark on recycling activities. Some 83.8% of the respondents were also willing to contribute for conversion of organic waste into compost in various ways: cash 5.8%, labour 5.8%, food remnants and other raw materials needed. The recyclable materials identified from the wastes by the respondents were: animal dung, bags, batteries, bottles, cable, cans, cartons, clothes, empty water sachets, glass, iron, knives, leaves, meter scales, paper, pipes, pet bottles, plates, rubber shoes, sandals, scrap pots, spoons, and others. Also, the communities were aware of the people or agencies who could buy the recycled items from the waste.

Composting experience recalled by the respondents

Some of the respondents had some experience in converting the wet waste into compost. Some of their experiences which they recalled from 6 to 50 years ago are: dig ground and leave waste for some time to decay (practiced 20 years ago); put it somewhere to decay (practiced 6 years ago); use the manure produced to plant maize (6 years ago); collect the waste and put into a sack until it decays (6 years ago); after burning the waste, take the un-burnt waste to the farm and bury it (about 50 years ago).

Associated Problems of Source Separation / Recycling of Wastes

Some of the challenges of source separation of solid waste and recycling as revealed by the study include: bad odour; lack of capital to start the business of recycling; disease/germs infection; environmental pollution; after separation, irregularity of disposal may lead to problems; may displace some people from their jobs; it is labour intensive; vehicles needed which are expensive;

removal of the waste to the recycling facility is difficult; time consuming; lack of available space for operations; epileptic power supply may affect continuation of recycling.

Turning the challenges to opportunities

A number of benefits accruable from waste recycling business are: generation of additional income; leading to reduction of waste; cheaper products are manufactured from recycled wastes; enhances cleaner environment; generation of more employment opportunities; increase in food production with the manure produced; reduce poverty level through income generation; empowers the farmers; improves agricultural output; provides income for the government through tax; improves the standard of living; provides raw material; reduce the scavengers roaming the dumpsites; biogas can be obtained for cooking.

Conclusions and Recommendations

The paper has shown the rate of generation and characteristics of solid waste in different population density zones of Ibadan. Some of the benefits derivable from regular waste assessment, economic utilization of solid waste as well as the factors militating against waste recycling in the areas. Based on the identified problems, it is suggested that waste assessment should be carried out regularly in all the LGAs and efforts should be put in place to segregate the wastes into dry (recyclables) and wet (compostable) categories as a start. Once segregation is accepted in the communities, residents should be encouraged to initiate waste sorting centres (as initiated by the authors in Ayeye Community, Ibadan), and move towards recycling activities through integrated waste recycling centres (Sridhar et al 1999, Wahab et al 2010). Local Government Councils should play more active roles in making these activities sustainable through commitment, and participatory stakeholder approach- the Environmental Planning and Management (EPM) process.

Acknowledgement

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Fractional Kelvin-Voigt Model for Liver Tissue in the Frequency and Time Domain

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Abstract.

The simulation of biomechanical properties of soft tissue is critical for developing a reality-based model for the characterization of benign and malignant tissue with the help of material parameters. The use of a fractional Kelvin Voigt model to fit experimental data from both the time and the frequency domain of benign porcine liver tissue is presented in this paper. The rheological properties are derived from experimental measurements using a parallel plate rheometer. The best fit gives a shear modulus of 220 Pa, a characteristic relaxation time of 6 s and a fractional exponent of 0.22 in the linear viscoelastic range for both domains.

Keywords: soft tissue modeling, shear rheology, fractional modeling

1. Introduction

Soft organic tissues show a very complex mechanical behavior which is characterized by non-linearities, anisotropy, viscoelasticity and in some cases also viscoplasticity. They often have a layered or an even more complicated structure (Holzapfel & Ogden, 2003; Tortora & Derrickson, 2008). Kauer (2001) found that the perfusion of the organs and their constituting tissues also play an important role regarding the elastic properties.

Over the past 15 years, interest has grown among the biomechanics and medical image analysis communities in not only the experimental determination of the material properties, but also the simulation of soft tissue deformation (Marchesseau, Heimann, Chatelin, Willinger, & Delingette, 2010). Constitutive models are widely known for their simplicity and ease of use, represented by combinations of springs and dashpots which allow the representation of viscoelasticity (Zhang et al., 2005). Examples are the Maxwell model (Ocal, Ozcan, Basdogan, & Basdogan, 2010), Kelvin Voigt (KV) model (Holt, Tripathi, & Morgan, 2008), Standard Linear Solid model (Veress et al., 2000) and Burgers model (Galford & McElhaney, 1970). More complicated constitutive models incorporate nonlinearity and anisotropy (Picinbono, Delingette, & Ayache, 2001) or hyperelasticity (Martins, Natal Jorge, & Ferreira, 2006; Weiss, Maker, & Govindjee, 1996). However, when the applied stresses are small, linear viscoelasticity models are often sufficient (Marchesseau et al., 2010).

In this article we focus on a simple fractional derivative modification of the spring-dashpot approach of linear viscoelasticity but we incorporate both time- and frequency-dependent material properties for the simulation. For this purpose, frequency-dependent and time-dependent data of porcine liver samples were obtained from frequency tests and creep tests using a parallel plate shear rheometer. Then the collected data from both experiments is combined in a model in order to obtain the viscoelastic material coefficients. In a similar approach (Ocal et al., 2010) a generalized Maxwell model was applied to imitate the frequency- and time-dependent dynamic response of bovine liver. The frequency-dependent data was measured with an impact hammer. The time-dependent data was obtained with ramp and hold experiments performed by a compression device. The model agrees well with the relaxation data and the storage and loss modulus dependent on frequency for frequencies larger than 50 Hz. A generalized Maxwell model with 3 Maxwell arms was found to suit the experimental data the best. Kerdok, Ottensmeyer, and Howe (2006) compared indentation results of perfused and unperfused porcine livers. A first and second order KV model was found to model the frequency-dependence and creep behavior, respectively. The first order KV model agrees well for frequencies larger than 1 and smaller than 50 Hz while the second order KV model agrees very well with the experimental creep data in the overall time interval. Another recent study conducts shear rheology experiments on porcine liver (Kobayashi et al., 2012). Creep and frequency tests were carried out and modeled by a power of time approximation which only gave good results for low frequencies. A fractional exponent of 0.12 was determined.

Recently physical and mathematical justifications for fractional derivative models were observed (Coussot, 2008). These represent a sort of interpolation between viscous and elastic behavior (Sasso, Palmieri, & Amodio, 2011). In 1967, Caputo (1967) introduced fractional calculus into the field of viscoelasticity. He proposed the fractional KV (KVFD) model which consists of a spring in parallel with a dashpot where the stress in the dashpot is equal to the fractional derivative of order α of the strain.

One application of a KVFD model to fit both the time- and frequency-dependent viscoelastic properties of hepatic tissue was found (Zhang et al., 2007). The *in vivo* frequency dependence of bovine liver was obtained by a crawling wave estimator and the *ex vivo* relaxation behavior by compression tests. Fitting the model to both frequency and relaxation data gave a complex Youngs modulus of approximately 17 kPa, a viscosity of approximately 5800 Pa s ^{α} and a fractional exponent of approximately 0.17. A similar approach by Taylor, Lerner, Rubens, and Parker (2002) presents uniaxial compression tests on bovine liver. Unfortunately, no resulting parameters are given. In

another application of the KVFD to the frequency dependence of canine liver DMA was conducted, resulting in an average Youngs Modulus of 1995 Pa, an average viscosity of 2310 Pa s^α and a fractional exponent of 0.169 (Kiss, Varghese, & Hall, 2004).

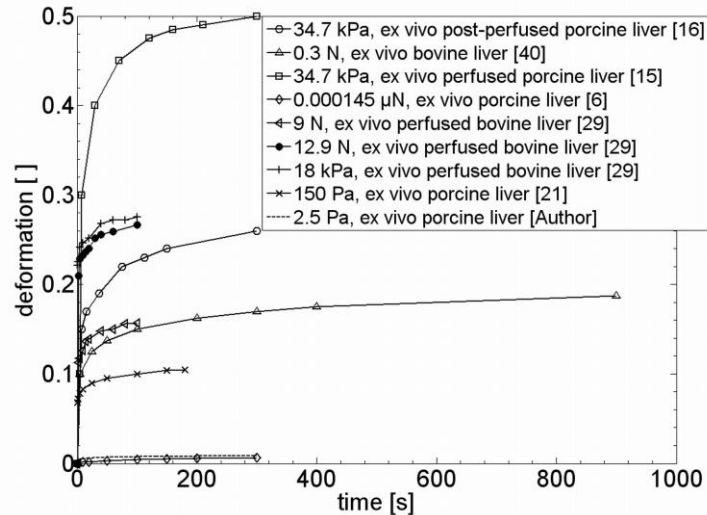


Fig. 1 Creep response for different measurement devices, sample geometries and applied loads

Few works in literature are known to focus on the creep behavior of liver tissue. Mazza, Nava, Hahnloser, Jochum, and Bajka (2007) investigated human liver *in vivo* using an aspiration device and correlated mechanical properties of liver with tissue histology. Kerdok et al. (2006) used a motorized viscoelastic soft tissue property indenter to perform large strain creep tests (approximately 50%) on unperfused whole porcine livers and used a 3D FEM model for simulation. Constantinides, Kalcioğlu, McFarland, Smith, and Van Vliet (2008) also use indenter on *ex vivo* porcine liver samples to extract mechanical properties of biological tissue. A modified KV model was applied and approximated the experimental results reasonably well. Taylor et al. (2002) described liver creep behavior with a fractional KV model. Experimental results were produced for bovine liver, tested under uniaxial compression. The agreement between experiment and model was good. Nasser, Bilston, and Tanner (2003) obtained creep curves from compression tests. High stresses well outside the LVE region were applied and lead to high deformations. Another recent study on porcine liver (Kobayashi et al., 2012) conducted shear rheometry with an applied stress of 150 Pa and modelled by a power of time approximation. The experimental results of the studies mentioned above are shown in Figure 1 and prove that the deformation behavior of liver strongly depends on sample geometry, perfusion, test method and the amount of the applied stress.

The frequency dependence of soft tissue has been investigated by several researchers. Typical investigation techniques are magnetic resonance elastography (Klatt et al., 2010; Kruse et al., 2012), US-based elastography (Marchesseau et al., 2010; Roulot et al., 2008), rheometry (Marchesseau et al., 2010; Kiss et al., 2004; Liu & Bilston, 2000) or indentation (Kim & Srinivasan, 2005; Ottensmeyer & Salisbury Jr., 2001). Results strongly depend on the selected investigation method, the amount of applied stress and the frequency range, see Figure 2. Furthermore, the post-mortem time, storage conditions and sample preparation have an impact on the results. Thus, mechanical characterization of biomaterial in general is explicitly complicated as problems in the reproducibility of data and in the standardization of measurement methods often occur. Part of the problem is the lack of standard methods and testing scenarios.

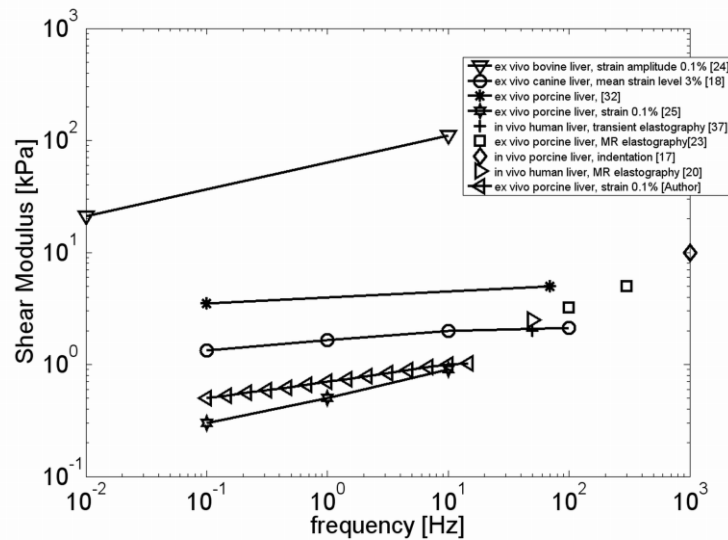


Fig. 2 Comparison of frequency dependence between different investigation methods

The proposed approach is a linear viscoelastic model which does not consider hyperelasticity, anisotropy or the porosity of the material. However, it is a simple model with only a few parameters that are descriptive of the deformation physics and which may allow to directly connect to the biology of a disease in the future.

2. Materials and Methods

The goal of this work is to construct a physically realistic mechanical model of the liver that is suitable for the simulation of frequency- and time-dependent behavior of hepatic tissue under small deformation. As such, the model should be as accurate as possible, but efficient enough to allow its application in real-time applications in surgical simulation tools. First, the material needs to be characterized experimentally.

2.1. Sample preparation

Similar to previous investigations (Wex, Stoll, Fröhlich, Arndt, & Lippert, 2013), we chose pigs from a heterogeneous pool of ecologically bred animals of various origins. Liver tissue was used *in vitro* and no IRB approval was required as the livers were obtained from a local butcher and qualified as food. The age of the pigs was approximately eight months and the weight was between 255 kg and 271 kg with the weight of the pig livers varying between 1.6 kg and 2.4 kg. Immediately after resection, the livers were put into a plastic bag containing a cooled solution of Krebs Ringer Hepes Buffer (glucose 10g, L-Glutamine 100 mM, KCl 560 mM, Na₂HPO₄·2H₂O 160 mM, MgCl₂·6H₂O 226 mM, CaCl₂·2H₂O 510 mM, NaCl 2.8 M, HEPES 100 mM). The buffer recipe was initially used for the isolation of pancreatic acinar cells (Halangk, Stürzebecher, Matthias, Schulz, & Lippert, 1997). To avoid injury by ice contact, the bag was wrapped in a cloth and then covered in ice. Samples of 35 mm in diameter and 3 mm in height were used. The samples were kept in Krebs Ringer Hepes Solution at 4°C until used. Only samples of isolated liver parenchyma excluding capsule were investigated. Samples did not contain any visible blood vessels.

2.2. Testing protocol

The rotary shear rheology experiments were carried out at room temperature (20°C) using a rheometer (Thermo Scientific HAAKE MARS) with a parallel-plate system. Normal force control with 0.6 N was applied to ensure contact between sample and upper plate. The testing protocol included a frequency sweep and a creep test. A new sample was taken out of the buffer solution for each test, gently padded dry and placed on the plates with glued on sandpaper (waterproof metal

sandpaper, roughness 80) to prevent the sample from slipping. After each test, the sandpaper was removed and a new set of sandpaper discs glued to the plates.

Each liver was investigated for post mortem times up to 4 hours which gave us 3 creep test results and 3 frequency test results per liver.

2.2.1. Dynamic testing

For the frequency sweeps an oscillatory deformation (strain γ) was applied to a sample and the response (stress τ) measured. The parallel plate rotary system was used to determine storage modulus G' , loss modulus G'' and phase angle δ . The complex shear modulus $G^* = G' + iG''$ indicates the material's overall resistance to deformation.

For a constant strain amplitude of 0.001, which is within the LVE region (Wex et al., 2013), the frequency was varied from 0.1 – 15 Hz with 3 cycles for each frequency.

Preconditioning prior to the frequency test was not conducted as the standard deviation of the frequency-dependent G' and G'' was acceptable.

2.2.2. Creep test

Earlier work by the authors (Wex et al., 2013) established the limit of the linear viscoelastic (LVE) range at approximately 0.8 % strain which confirms other studies (Marchesseau et al., 2010; Liu & Bilston, 2000).

In creep a constant shear stress was applied and the deformation of the sample material measured. The applied stress of $\tau_0 = 2.5$ Pa was chosen so that resulting strains were within the LVE range as we wanted to observe linear viscoelastic material behavior. In order to find out whether the applied stress of $\tau_0 = 2.5$ Pa shows LVE behavior, the applied stress was varied and the compliance $J(t) = \gamma(t) / \tau_0$ investigated. We found that an applied stress of 2.5 Pa does not exceed the LVE range. The shear stress of $\tau_0 = 2.5$ Pa was applied for 300 seconds.

Preliminary tests showed that the standard deviation for the time-dependent strain is extremely high. Thus, we introduced a rest phase of 15 minutes for which the sample is in place with a pre-set normal force value of 0.6 N. Subsequently, the deformation is set to zero and the shear stress from the creep test is applied.

2.3. Modeling

This paper aims to find a constitutive model that describes liver tissue behavior not only in the frequency domain but also in the time domain, as most models only give satisfactory results in one of the two domains. As introduced in Wex et al. (2013), this paper focuses on a fractional derivative representation of the KV model. The model is described by a spring in parallel with a spring-pot unit which exhibits linear viscoelastic behavior intermediate between pure elastic and viscous responses. In the time domain the KVFD model is given by

$$\sigma(t) = G_0 \varepsilon(t) + G_1 \tau^\alpha \frac{d^\alpha \varepsilon(t)}{dt^\alpha} \quad (1)$$

with the elastic components G_0 and G_1 , the stress σ , the strain ε , the characteristic relaxation time constant τ and a fractional derivative of the dimension α (Chatterjee, 2005; Koh & Kelly, 1990; Rossikhin & Shitikova, 1998). With $\tau' = \left(\frac{G_1}{G_0}\right)^\alpha \tau$ equation (1) transforms into

$$\sigma(t) = G_0 \varepsilon(t) + G_0 \tau'^\alpha \frac{d^\alpha \varepsilon(t)}{dt^\alpha} \quad (2)$$

and gives a constitutive equation for the expression of time domain behavior. Equation (2) can then be transformed into the Fourier domain resulting in the complex modulus in the frequency domain:

$$G^*(\omega) = G_0 + (i\omega\tau')^\alpha G_0 \quad (3)$$

Thus, the storage modulus is:

$$G'(\omega) = G_0 + \cos\left(\frac{\alpha\pi}{2}\right) \omega^\alpha \quad (4)$$

and the loss modulus is equal to:

$$G''(\omega) = G_0 \sin\left(\frac{\alpha\pi}{2}\right) (\omega\tau')^\alpha \quad (5)$$

The parameters G_0, τ', α can then be estimated in the frequency domain and in the time domain. The biggest advantage of the model is that it only includes 3 parameters with straightforward physical interpretation. When $\alpha \rightarrow 0$, the fractional unit behaves like a Hookean spring. When $\alpha \rightarrow 1$, it behaves like a Newtonian dashpot. For intermediate values of α it behaves as a viscoelastic material (Coussot, 2008).

The equations (1), (4) and (5) were implemented in *Matlab*. The *Matlab* toolbox “Matrix approach to discretization of ODEs and PDEs of arbitrary real order” (Petráš, 2011; Podlubny, Skovranek, & Vinagre, 2009) was applied to solve the fractional differential equation in (1). The toolbox allows obtaining the discretization of ordinary and fractional differential equations by replacing the derivatives with their discrete analogs in the form of triangular strip matrices. The matrix approach allows the easy solution of ordinary differential equations with derivatives of any order. The following problem can be solved by the matrix approach:

$$A\varepsilon''(t) + BD_t^\alpha \varepsilon(t) + C\varepsilon(t) = \sigma(t) \quad (6)$$

which is similar to (1) with $A = 0$, $B = G_0\tau'^\alpha$ and $C = G_0$. A least squares method was used in *Matlab* to find a best fit.

3. Results

The KVFD model parameters G_0, τ', α are extracted in order to give the best fit to the experimental data. First, a frequency curve fit was conducted and the resulting parameters applied to the time domain to find out whether the model gives a reasonably good fit in both domains. Furthermore, a creep curve fit was conducted and the resulting KVFD model parameters compared to the frequency curve fit results. Ultimately, a fit including the experimental results from both domains was conducted.

3.1. Frequency curve fitting

Figure 3 (a) shows the experimental data of the frequency dependence of G' and G'' of porcine liver and the corresponding KVFD fit. The resulting parameters of all curve fits are shown in Table 1. Experimental and simulated curves agree very well. When the resulting parameters from the frequency curve fit are applied to equation (1), the resulting creep curve agrees reasonably well with the mean value of the experimental creep curves, see Figure 3(b).

Table 1: Curve fitting results for the three different fitting methods

	Frequency	Creep	Combined
G_0 [Pa]	258.6	132.5	220.2
τ' [s]	1.7	1234.7	6.2
α []	0.2352	0.219	0.2176

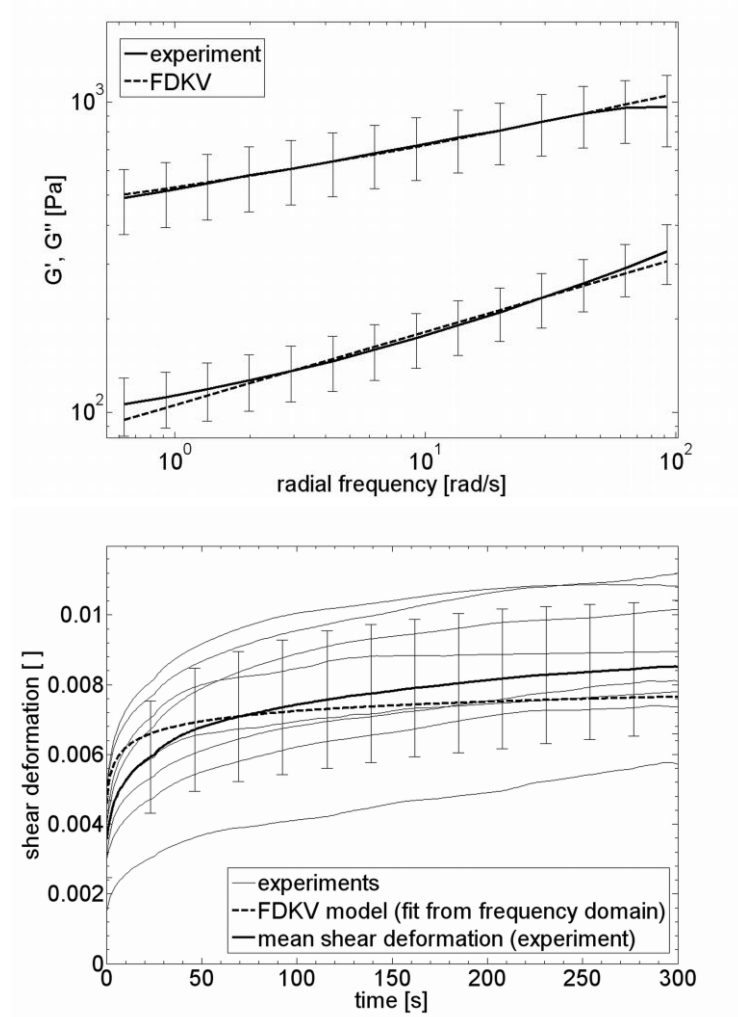


Fig. 3 (a) Frequency and (b) time dependence of liver tissue and corresponding KVFD model from frequency curve fit ($G_0 = 258.6$ Pa, $\tau' = 1.7$ s, $\alpha = 0.2352$)

3.2. Creep curve fitting

If the creep curve fit is conducted first, a very good agreement can be observed between experimental and simulated curves, see Figure 4 (b). The application of the thus obtained parameters G_0, τ', α to the frequency-dependent data leads to G' and G'' of the correct order of magnitude but shows a distinct difference between simulated and experimentally obtained G' and G'' , see Figure 4(a).

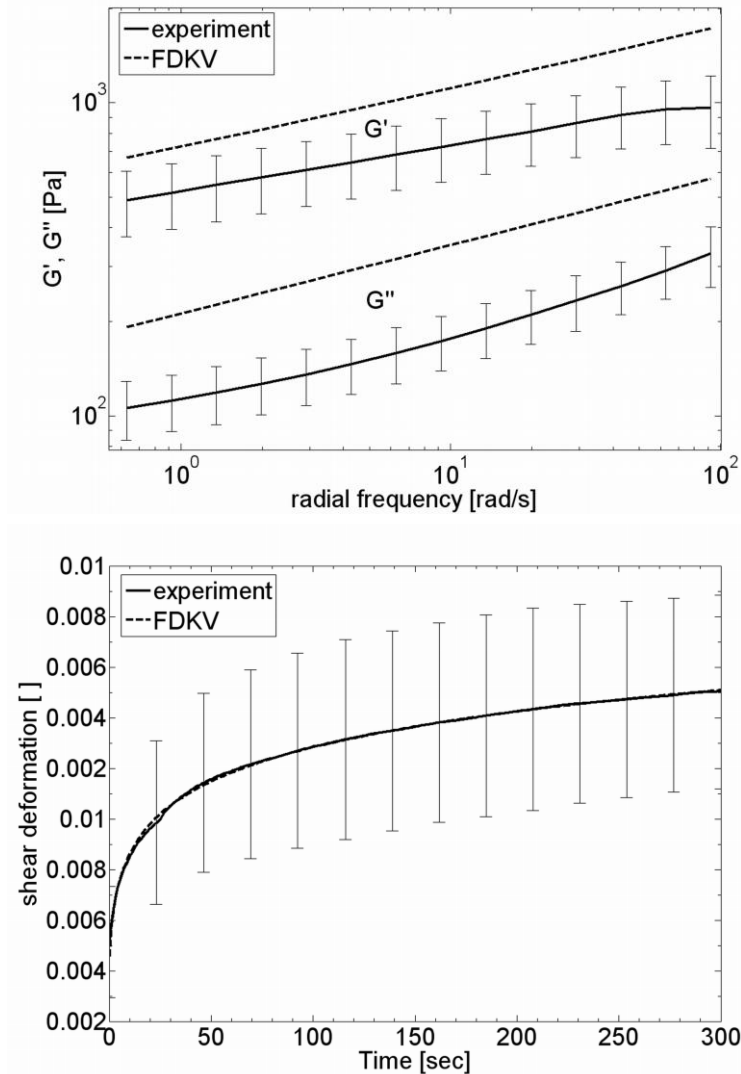


Fig. 4 (a) Frequency and (b) time dependence of liver tissue and corresponding KVFD model from creep curve fit ($G_0 = 132.5$ Pa, $\tau' = 1234.7$ s, $\alpha = 0.219$)

3.3. Combined fitting

For the combined fitting a least squares procedure is applied to the G' and G'' curves as well as the creep curve. In order to find a fit that suits all three data sets best, their number of measuring points has to be equal-weighted. Thus, the number of measuring points in the creep test has to be reduced from 300 to 14 which is the number of measuring points in the frequency test.

Furthermore, the data for G' , G'' and γ were normalized. Therefore, the maximum G' , G'' and γ values were set equal to 1 to achieve data of the same magnitude. This allows for an improved optimization process of the least squares method as the differences between experimental and simulated data is also of the same magnitude for all 3 data sets. Figure 5 shows the resulting KVFD model fit for the combined fitting process with G_0, τ', α as mentioned in Table 1.

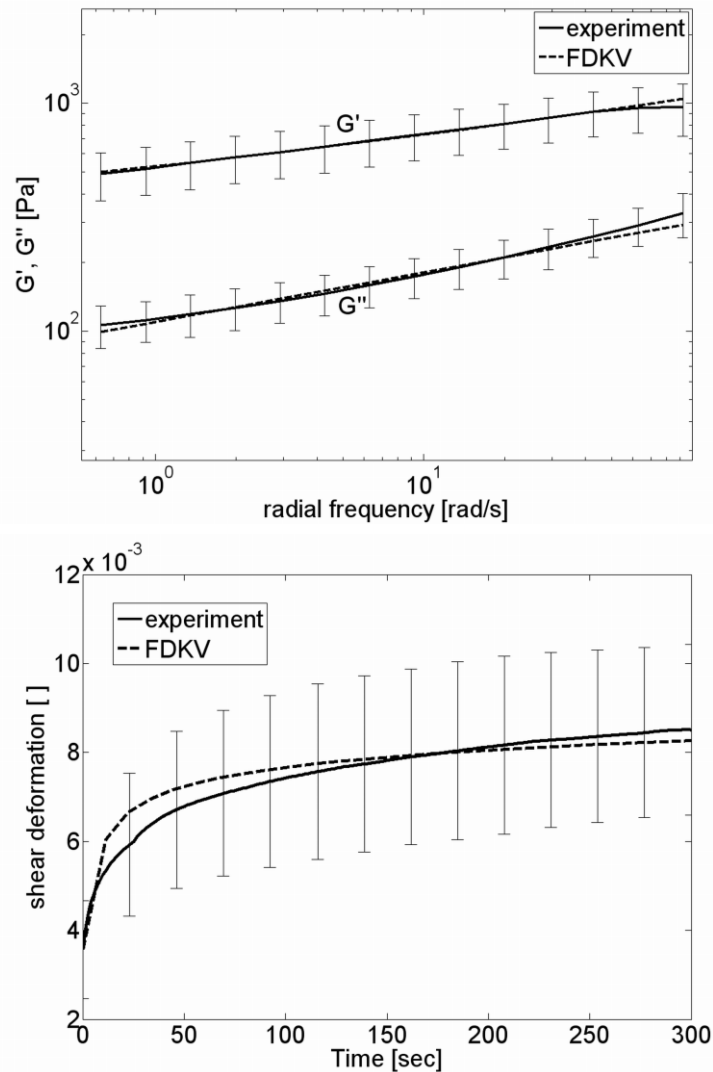


Fig. 5 (a) Frequency and (b) time dependence of liver tissue and corresponding KVFD model fit for combined fitting ($G_0 = 220.2$ Pa, $\tau' = 6.2$ s, $\alpha = 0.2176$)

4. Discussion

4.1. KVFD model

Most models and their representative equations are very complex and involve an excessive number of material parameters. In contrast, the KVFD model is suitable to simulate experimental data within a broad frequency range using only three parameters, G , τ' and α . The introduction of the fractional part improves the KV model since the best fit was obtained for a fractional exponent unequal to 1. A fractional exponent of 0.22 points towards a dominating elastic material behavior in the investigated frequency range under small deformation since a viscoelastic material is more governed by elastic properties than by viscous properties when the derivative order α is close to 0. The estimated exponent of 0.22 agrees well with Klatt et al. (2010), where an α of 0.25 was observed.

The simplicity of the model makes up for the slight discrepancy between experiment and simulation in the combined fit. The proposed model is easy and fast to calculate which is important for its future application for real time computer simulation in surgery where a compromise between biomechanical accuracy and computational efficiency must be found (Marchesseau et al., 2010). In

the future the parameters G , τ' and α of the KVFD model shall be indicators for the state of a liver. A sample containing cancerous tissue is likely to be stiffer and produce a larger Young's Modulus which is a measure for the stiffness of a material. The effect tumorous tissue has on τ' and α will have to be investigated in the future. Our aim is to set up a comprehensive database of properties of benign and malignant human liver tissue from a large number of experiments because of the diversity of mechanical properties found in soft biological tissues. This database can then be used intraoperatively to diagnose liver diseases in real-time simply by acquiring the mechanical properties of the material in question using, for example, a customized endoscope equipped with pressure sensors at the tool tip.

Most studies, focusing on viscoelastic material properties of soft tissues typically rely on the experimental data collected from one type of experiment only. Either relaxation/creep or dynamic loading experiments are conducted to model time- or frequency-dependent material properties of the soft tissues being tested, respectively. However, due to the nature of these experiments, the information that can be extracted from each of these experiments is different, although a conversion from time to frequency domains or vice versa is possible through Laplace transformations. We showed that an overall fit to the experimental data of both time and frequency domain can be achieved if the results of both experiments are taken into account in the analysis (Zhang et al., 2007; Ocal et al., 2010; Kerdok et al., 2006; Kobayashi et al., 2012; Coussot, 2008). Only one other study was found using a KVFD model to simulate viscoelastic material behavior of liver tissue in both the time and frequency domain (Zhang et al., 2007) which led to a similar fractional exponent which is typical of healthy human liver (Klatt et al., 2010), but higher Young's modulus and higher viscosity. Those differences might be based on the fact, that in Zhang et al. (2007) relaxation data was used instead of creep data, that the investigated frequencies with 80-210 Hz were much higher than our frequencies of 0.1 Hz – 13 Hz and that the liver samples were frozen prior to testing.

4.2. Simulation process

Kiss et al. (2004) noted that in fitting their experimental data on canine liver to the KVFD model, the real part agrees better with the model than does the imaginary part. This was due to the fact that the parameters were determined using the magnitude of the complex modulus, which tends to be dominated by the real part, and therefore the contribution from the imaginary part is less significant than the contribution from the real part. We avoid this problem by including both G' and G'' in the simulation process. Furthermore the G' , G'' from the frequency test and γ from the creep test were normalized. The maximum G' , G'' and γ values were set equal to 1 to achieve data of the same magnitude and to allow the optimization process to include all three data sets to an equal amount without penalizing the creep data because they are of the magnitude 10^{-3} compared to 10^3 and 10^2 for G' and G'' respectively.

Another possibility of improving the quality of the optimization result is to use more discretization points. In order to allow for more discretization points in the optimization process, the experimental procedure has to be adjusted and more measurement points will have to be taken.

Another issue of the numerical optimization process is that one can not necessarily assume one has found a global minimum but only a local minimum. It may frequently be useful to optimize the function several times with different starting conditions in order to obtain the best results.

4.3. Experiments

We confirmed that the KVFD model does not hold at high frequencies (typically above 100 rad/s) (Djordjevic, Jaric, Fabry, Fredberg, & Stamenovic, 2003). But for frequencies smaller than 100 rad/s investigated in our analysis, the KVFD model provided a good fit.

The still relatively high standard deviations observed in the frequency and creep data are typical for soft tissue. Many researchers (Kruse et al., 2012; Nicolle, Venzin, & Palierne, 2010; Samur, Sedaf, Basdogan, Avtan, & Oktay, 2005) precondition their samples to ensure a steady-state response of the investigated material. Other researchers (Kerdok et al., 2006; Brown et al., 2003, Chatelin et al., 2011) claim that preconditioning does not reflect the material's actual properties in its natural state. Additionally, preconditioning is suspected to increase the release of fluid from the tissue (Kerdok et al., 2006). As the authors wanted to change the physiological conditions of the liver tissue as little as possible when making their mechanical measurements, no preconditioning was applied to the samples in the frequency test since the dynamic testing resulted in reproducible results with relatively small standard deviations. However, the performance of creep tests led to results with very high standard deviations. Thus, a preconditioning process had to be introduced at this point that affects the sample material as little as possible but leads to smaller standard deviations in the parameters measured. Most approaches use oscillations to normalize the samples (Cheng, Clarke, & Biston, 2009; Liu & Bilston, 2000). Applying oscillations with different strains did not give us the desired results. Therefore, we used a different approach of compression and rest as stated in section 2.2.2 which reduced the standard deviation greatly. The addition of the wait period to the testing protocol of the rotational tests does not qualify as a typical preconditioning procedure as no additional repeated cycling was conducted to alter the mechanical response of the investigated material to produce a steady state response (Kruse et al., 2012; Nicolle et al., 2010, Samur et al., 2005). In the future our aim will be to further reduce influences that enhance the standard deviation. Maybe a faster "preconditioning" process can be found that does not elongate the test length so much.

Subsequently, the dehydration of the soft tissue samples has to be considered, as dehydration seems to make biological structures more rigid (Nicolle et al. 2010). In order to avoid dehydration as much as possible, Nicolle et al. (2010) propose the immersion of samples at the rheometer or the use of a silicon oil around the outer edge of the sample. They also state that experiments with testing times longer than approximately 800 s are affected by tissue dehydration. Our total creep test duration is 1200 s which is slightly higher than the creep test durations of other researchers (Kerdok et al., 2006; Kobayashi et al., 2012, Taylor et al., 2002). Typical signs for dehydration were not observed. Thus we assume that the results are unaffected by dehydration. However, the topic has to be kept in mind and a future reduction of the experiment length and the application of silicon oil or an immersion of the sample in saline solution during the test is advisable (Nicolle et al., 2010).

5. Conclusions

- Having conducted a frequency curve fit and a creep curve fit separately shows that the KVFD model, which is based solely on 3 parameters, is a suitable model to simulate the viscoelastic properties of porcine liver.
- The KVFD model allowed the simulation of both time- and frequency-dependent material with the same material constants.

Declaration of Interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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Women Participation in Governance: Panacea for Corruption in Nigeria?

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Abstract

The motivation for this study is that corruption has become the most pervasive national infirmity in Nigeria. The study further highlights that in Nigeria, women participation in governance is comparatively on the ascendancy; even in the face of other persisting national challenges. Considering the geometric increase in women participation in governance therefore, the study examines whether women participation in governance could be a panacea for corruption in Nigeria. The general objective of the study was to examine women participation in governance, as panacea for corruption in Nigeria. The specific objectives were to: (i) establish if governance challenges in Nigeria are mainly associated with men and (ii) determine the extent to which women participation in governance is a panacea for corruption in Nigeria. The methodology for the study was deductive inference, on the basis of which logical conclusions were drawn. The study has used the elite theory as theoretical framework. No evidence was found in the study, in support of the position that governance challenges in Nigeria are mostly associated with men. The supposition of a positive relationship between women participation in governance and corruption-reduction was not substantiated by the findings of the study. Rather, the pervasive corruption in Nigeria can be hinged on the elite leadership. The heartbeat of the panacea would be found more in the psychology and worldview of the Nigerian elite, which requires revolutionary remolding.

Keywords: Women, Governance, Panacea, Corruption, Participation

Introduction

Corruption has become the most pervasive national infirmity in Nigeria. It is incontestable although, that commendable documentation of the various dimensions of corruption in Nigeria has actually been made (see Ugwu, 2002; Fagbadebo, 2007; Ogundiya, 2009). Very many conceited speeches have also already been delivered on the subject matter of corruption in Nigeria. Ilevbare (2014) further posits as follows:

Some of the probes that show evident lack of political will to decisively deal with the menace of corruption in Nigeria, include the KPMG report that indicted the Nigeria National Petroleum Corporation (NNPC) for corrupt practices; The Nigeria Extractive Industries Transparency Initiative (NEITI) audit report exposing 10 years of corruption in the upstream and downstream sectors of the oil and gas industry; the probe of the Pension Fund Management by the Senate Joint Committee on Public Service and Establishment, State and Local Government Administration; the Security and Exchange Commission (SEC) probe that exposed alarming revelations of corruption in the capital market; the probe of the oil subsidy regime by the Ad hoc-committee of the House of Reps; the non-prosecution of those indicted in the Halliburton LNG bribery scandal, the recent Stella Oduah BMW scandal and the unsatisfactory explanation the NNPC has given for the \$10.8 billion of crude oil earning the Central Bank of Nigeria (CBN) declared missing. The list is almost inexhaustive (Ilevbare, 2014). Ajayi (2014) quotes the former Governor of Lagos State, Lateef Jakande as recently describing corruption in Nigerias as a national tragedy

In addition, numerous ineffective panels have been inaugurated, all on the issue of corruption in Nigeria (Eze, 2002). Fagbadebo (2007) cites Diamond (1991) and Bello-Imam (2004), to identify some of the previous corruption-fighting exercises in Nigeria, as follows: the Jaji Declaration of the Murtala/Obasanjo administration, Ethical Re-orientation Campaign of Shagari's Second Republic, War Against Indiscipline (WAI) of the Buhari/Idiagbon regime, Babangida's Committee on Corruption and other Economic Crimes, the numerous probe panels of the Abacha years and the current War Against Corruption (in 2007). Nonetheless, the critically growing trend of corruption in the Nigerian State remains unabated. Hence, Omo-Ikirodah (1979) cited in Agalamanyi (2002), saw corruption in Nigeria as national religion.

The strengths and potentials of women in national development have been demonstrated by Izueke and Idika (2009) who have highlighted that a critical look at nature's arrangement in child bearing and rearing would reveal the enormous strengths and potentials women have when juxtaposed with men. Citing Okoli (1999) they further noted that a woman brings a child into the world in partnership with a man but the woman subsequently outplays the man in this wonderful and sacred game by appropriating or monopolizing a larger part of the socialization function, a vital process in the up-bringing of the child. Izueke and Idika (2009) further posit that in Nigeria, the population of men and women are almost equal and it therefore follows that the neglect of women in the development process of Nigeria would constitute a human resource chasm. We further cite Izueke and Idika (2009:227) as follows:

A further survey of the potentials of women can be seen from their articulate and organizational abilities. There are innumerable women associations and cooperatives in Nigeria. In churches, villages and towns, the roles of women organizations in development are visible. In the South Eastern part of Nigeria, many development projects and programmes came as a result of "August Return or Meeting". They use these associations or meetings to showcase their leadership qualities and potentials. Women are blessed with the ability to persist and pursue

their desires. They have the ability to develop passion for what they believe in. Unlike men, when they make any policy, they see to the full implementation of the policy.

Another interesting quality of women that will make them a veritable tool of national development is that they care about details. Women are teachers, care givers, kind hearted, ready to share and are dependable. These qualities and potentials of women make them to be very strategic in any development process. They are in a better position, if empowered to accelerate the development process (Izueke and Idika, 2009:227).

Hence, women participation in governance, as panacea for corruption in Nigeria attracts research attention. In this regard, one of the areas in which the current Jonathan Administration in Nigeria has clearly demonstrated strong determination is in the encouragement of women participation in national affairs. According to Enekwechi (2014), under the Jonathan administration, women empowerment which was hitherto relegated to the background has suddenly received practical attention. For the first time in Nigeria's history, he argues, there are more women in the federal cabinet. This unprecedented and remarkable move demonstrates that the Jonathan administration is sensitive to the yearnings of Nigerian women and its citizens (Enekwechi, 2014).

Alison-Madueke (2013) also provides a rich source of evidence that the Jonathan administration has been gender sensitive. According to Odunlami (2013), the Jonathan administration is estimated to have offered an unprecedented more than 30% political appointment to women so far, exclusive of non-political opportunities, especially in the military, judiciary and education that the administration has provided for the female gender. There is the big matter of the first Rear-Admiral in the Nigerian Navy, Itunu Hotonu; the Group Managing Director/Chief Executive Officer of Navy Holdings who is Nigeria Navy's and, indeed, Africa's first female Rear-Admiral, so promoted by Jonathan in December 2010. Exactly a year later, the president picked another female pioneer in Nigeria when he wrote Flying Officer Blessing Liman into the annals as the first female military pilot in the Nigerian Air Force (Odunlami, 2013). There is also the innovation of the "Jonathan Queens", a team of 20 girls admitted in October 2011, to the Nigerian Defence Academy (NDA), as its pioneer set of female Regular Combatants, which is quite historic because; for the past 50 years that the NDA has been admitting Regular Combat Cadets, its preferences, until the emergence of the "Jonathan Queens" had been men (Odunlami, 2013).

Ajani (2013) further highlights as follows: The leading women in the administration are Justice Aloma Mariam Mukhtar, GCON - Chief Justice of Nigeria; Dr. (Mrs.) Ngozi Okonjo-Iweala, CFR - Coordinating Minister for the Economy and Minister of Finance; Diezani Alison-Madueke (Mrs.), CON - Minister of Petroleum Resources; Mrs. Omobola Johnson - Minister of Communication Technology; Mrs. Hadiza Ibrahim Mailafa - Minister of Environment; Hajia Zainab Maina, MFR - Minister of Women Affairs and Social Development; Mrs. Sarah Reng Ochekepe - Minister of Water Resources; Princess Stella Oduah, OON - Minister of Aviation; and Lady Amal Pepple, CFR - Minister of Lands, Housing and Urban Development. Others are Professor (Mrs.) Ruqayyatu Ahmed Rufa'i, OON - Minister of Education; Oloye Olajumoke Akinjide - Minister of State for Federal Capital Territory (FCT); Hajia Zainab Ibrahim Kuchi - Minister of State for Power; Erelu (Dr.) Olusola Obada - Minister of State for Defence; and Professor (Mrs.) Viola Onwuliri - Minister of State (1) for Foreign Affairs. The women in diplomacy are Prof. Joy Ogwu, Ambassador/Permanent Representative of Nigeria to the United Nations; Mrs. Amina Mohammed, Special Adviser to the UN Sec Gen on Post-2015 Development Planning; Hajia Salamatu Hussaini Seleiman, ECOWAS Commissioner for Political Affairs, Peace and Security; and Dr. Aisha Laraba Abdulahi, AU Commissioner for Political Affairs. There are in addition, 11 Nigerian women Ambassadors and High Commissioners, appointed by President Jonathan (Ajani, 2013). On the basis of the foregoing, the Jonathan Administration has truly, effectively promoted the course of high presence of women in governance.

Thus, if the administration has done so well in the area of women participation in governance, the impact of the increased women participation on the national corruption index would begin to require some investigative attention. The general objective of this study therefore, is to examine women participation in governance, as panacea for corruption in Nigeria. The specific objectives are to: (i) establish if governance challenges in Nigeria are mainly associated with men and (ii) determine the extent to which women participation in governance is a panacea for corruption in Nigeria. The methodology for the study is deductive inference, on the basis of which logical conclusions are drawn.

Theoretical perspective

The theoretical framework for the study is the elite theory. In this regard, Parry (1997) cited in Osakwe (2002:180) defined elite as the small minority who appear to play an exceptionally influential part in political and social affairs or that group which appears to wield control over crucial policies. The elite govern and make policies for the society. In Nigeria, the few that govern and make policies are the elite, irrespective of their gender. Thus, the portrait of a small minority begins to emerge, in the context of governance and panacea for corruption in Nigeria.

Conceptual Issues

The Concept of Governance

According to the World Bank (1991:23), governance in general has three distinct aspects:

- (i) the form of political regime (parliamentary/presidential, military/civilian, authoritarian/democratic);
- (ii) the processes by which authority is exercised in the management of a country's economic and social resources; and

(iii) the capacity of governments to design, formulate, and implement policies and in general, to discharge government functions. Fukuyama (2013:3) defines governance as a government's ability to make and enforce rules and to deliver services regardless of whether that government is democratic or not. In this regard, Fukuyama (2013:3) cites Mann (1984) in seeing governance as being more in tune with "infrastructural" rather than "despotic" power.

However, this attempt at conceptual demarcation rather appears as the differentiation between six and half a dozen. It is sufficient to see in this conceptualization that governance is what people in power do. But the tendency to perceive governance in the context of World Bank (1991:23) and Fukuyama (2013:3), is becoming increasingly outmoded. Hence, since the 1980s, argues Bevir (2013:1) the word "governance" has become ubiquitous, as the governance concept has spread rapidly both because changing social theories have led people to see the world differently and because the world itself has changed. New theories and practices have drawn attention away from the central institutions of the state and towards the activity of governing and much of the activity of governing now involves private and voluntary organizations, as well as public ones (Bevir, 2013:1)

. In current theoretical terms therefore, governance is fundamentally, the process of governing. It is what governments do to their citizens and it is also, what corporations and other organizations do to their employees and members (Bevir, 2013:2). Thus, in empirical terms, governance refers to a shift in public organizations since the 1980s, whereby the world of government has changed and increasingly governments rely on private and voluntary sector actors to manage and deliver services (Bevir, 2013:3). Thus, a distinctive feature of governance is the increasing range and plurality of stakeholders (Bevir, 2013:6). In essence, every discussion on governance invariably becomes a discussion on good governance, although what counts as good governance is still a matter of contentious debate (Bevir, 2013:4).

Governance therefore, usually connotes positive endeavours. Essentially, “governance” in this paper is not synonymous with “government”. Moreover, it is not conceptually identical with “politics”. Hence, in the context of this paper, “women in governance” relates more with “women in leadership positions”.

Conceptualizing Corruption

Corruption is critically problematic to conceptualize. There is even an emerging school of thought that sees corruption as a positive phenomenon that can be beneficial to political development, by contributing to economic development, national integration and governmental capacity (Amujiri, 2002:77). Anugwom (2002:87) agrees that corruption curiously is not without some benefits, as overcoming red-tapism and the slow-grinding machine of bureaucracy, which oftentimes militate against economic activities, are positive aspects of corruption. However, like an elephant, even though it may be difficult to describe, it is generally not difficult to recognize when observed (Tanzi, 1998:8). The most popular and simplest definition of corruption is that it is the abuse of public power for private benefit (Tanzi, 1998:8). Corruption has also been described as a deviation from norms, traditions, and generally approved ways of relationship and interaction in public and private offices, thereby encouraging cheating, nepotism, favouritism, tribalism, bribery, dishonesty, mistrust and disobedience to constituted authority (Ugwu, 2002:16).

The different perspective through which corruption is viewed notwithstanding, a common ground of opinion conceives it as the perpetration of a vice against the public well-being (Fagbadebo, 2007:030). We subscribe to this viewpoint on the concept of corruption. For purposes of clarity, cases of corruption in this paper are delimited to the genre of corruption, classifiable as political corruption. Ebegbulem (2012) refers to political corruption as a form of corruption perpetrated by the political elite. Political corruption, it must be added, often has economic connotations. In this study, the identified cases of political corruption actually have such economic nuances.

Women Participation in Governance as Panacea for Corruption in Nigeria: The Theoretical and Empirical Perspectives

Having seen the tremendous increase in the number of women in governance in Nigeria and their inherent potentials, it would be of interest to investigate whether their massive presence has positively impacted on corruption reduction in Nigeria. We further posit that cases of corruption in the Nigerian state are indeed innumerable and their magnitude is usually incredible.

For purposes of current illustration, being that a legion of corruption cases are already documented in the reports of earlier studies, let us take the bothersome cases from Sanusi Lamido Sanusi, the Governor of the Central Bank of Nigeria (CBN), as whistleblower. On November 27, 2010, at the 7th Convocation Lecture of Igbinedion University, Sanusi called the attention of the nation, to the fact that twenty five percent of the overheads of the Government of Nigeria are consumed by the National Assembly (Iredia, 2010). This situation borders on monumental corruption, as perpetrated by Nigeria’s political elite. When the Nigerian Senators subsequently summoned the CBN Governor to their Chambers, believing he would claim to have been misquoted, Mr. Sanusi stood his ground. Sanusi Lamido Sanusi told his hosts, majority of whom displayed open antagonism towards him, that the figure he used to arrive at his conclusion was from the Budget Office of the Federation; as such he does not have any reason to retract the statement accredited to him in the media (Ajani, 2010). On 27th November, 2012, the CBN Governor again alerted the Nigerian nation that the country spends 70 per cent of its earnings on salaries and entitlements of civil servants and politicians (Leba, 2012). Sanusi, made the disclosure in his presentation at the Second Annual Capital Market Committee Retreat in Warri, Delta State. To call a spade by its appropriate name, this is also corruption, as according to Sanusi, these two classes of Nigerians constitute less than 1% of the Nigerian population.

Furthermore, Hassan (2014) highlights that the CBN governor had written a letter to President Goodluck Jonathan in September 2013, in which he said about \$50 billion oil sales proceeds, were not remitted to public coffers by the Nigerian National Petroleum Corporation (NNPC). Following the leak of the letter, the Nigerian Senate asked its Finance Committee to investigate the issue. When Mr. Sanusi first appeared before the committee in December 2013, he said the unremitted amount was actually \$12 billion, but Finance Minister, Ngozi Okonjo-Iweala, told the same committee it was \$10.8 billion. Both of them however, said the figures were still being reconciled and so, the committee asked them to conclude the reconciliation and return. In the meantime, NNPC announced that all the alleged missing funds had been accounted for and that the unremitted part was spent on fuel subsidy, pipeline repair and other operations. When the Senate Committee on Finance resumed hearing on this matter on February 04, 2014, Sanusi said the Corporation has yet to account for \$20 billion (equivalent of N3.25 trillion) from the total \$67 billion oil sales receipts from January 2012 to July 2013 (Hassan, 2014). In his submission at the resumed hearing, Sanusi said NNPC was still to account for \$12 billion out of domestic crude oils sales, \$6 billion shipped on behalf of the NNPC and \$2 billion “third-party financing”, making a total of \$20 billion (Hassan, 2014, Ekott, 2014).

As Sanusi (who by his position in government, should be taken seriously when he speaks), continues to insist that \$20.0 billion was missing from government coffers, as expected remittances from the Nigerian National Petroleum Corporation (NNPC), the issue that arises is critically the issue of corruption, as masterminded by the Nigerian political elite. According to Sanusi, all we have said as CBN to which there is no disagreement is that NNPC shipped \$67bn worth of crude. They have repatriated or we have established that \$47bn has come back to the federation. There is a \$20bn that has not come back to us. The burden of proof is on NNPC (Aborisade, 2014).

There are two principal women stakeholders in the drama of remittances and the unremitted, reconciliation and the irreconcilables, the crux of which is corruption. These are the Minister of Finance, Dr Ngozi Okonjo-Iweala and the Petroleum Minister, Mrs. Diezani Alison-Madueke. Nobody has directly accused them of complicity in the matter of the allegedly missing \$20bn or \$10.8 billion. However, while the CBN Governor apparently fights as a lone ranger on the matter, both the Ministers of Finance and Petroleum have been on the side of the intransigent NNPC. Essentially, there is something untoward about the unremitted but statutorily required remittances of the NNPC to the CBN, which borders on corruption. This happened under a woman Minister of Finance, who has not been forthcoming on the acceptance of the occasioning impropriety and another woman Petroleum Minister, who directly supervises the octopus NNPC. The scorecards of the women in this instance detract from Nigeria’s corruption perception index. Hence, the jubilations about the increasing profile of women in governance in Nigeria, particularly under the Jonathan administration, still borders on the theoretical. In other words, the jubilations are only hinged on the assumption that the more there are women in governance, the more nationally progressive the Nigerian state becomes. The empirical tests in this study are proving the contrary.

Indeed, women participation in governance in Nigeria is commonly taken to be synonymous with women participation in government or women participation in partisan politics (see Inyang, 2013). Contrary to this orthodox thinking, the reality is that there is already widespread women participation in governance in Nigeria; from the executive arm of government to the bureaucracy, civil society groups to commerce and industry, particularly in the banking industry, from where the advance payment guarantees (APGs) that facilitate dubious release of funds from government’s treasury emanates.

Women are easily seen at the commanding heights of the banking industry in Nigeria. According to Bevir (2013), governance can refer abstractly to all processes of governing. It supplements a focus on the formal institutions of government, with recognition of more diverse activities that blur the boundary of state and society. It draws attention to the complex processes and

interactions involved in governing. Governance can also refer more concretely to the rise of new processes of governing that are hybrid and multi-jurisdictional with plural stakeholders working together in networks. It describes recent changes in the world (Bevir, 2013:5). If for instance therefore, the Nigerian nation spends 70 percent of its earnings on civil servants and politicians, when this class of Nigerians constitutes less than 1% of the population, the spending act is an act of corruption. We recall here, the definition of corruption as the pervasion of normalcy in order to gain an undue advantage (Uche, 2002:140). There may not be many women among the beneficiary politicians but there are certainly very many women among the civil servant beneficiaries. It is not on record that the women members of the executive arm of government, women senior civil servants and women good governance advocates, have been objecting to the scenario of unfair consumption of national resources, by civil servants and politicians, particularly in the case of civil servants. The groups identified above are all in empirical terms, participants in the governance process in the Nigerian State.

We further highlight that governance differs from government in that it now focuses less on the state and its institutions and more on social practices and activities (Bevir, 2013:1). Hence, issues of governance, according to (Bevir, 2013:6) now loom large in a world where government has become an increasingly complex matter, dependent on diverse stakeholders, with formal and informal links to one another. Thus, many of the ideas, activities and designs of governance appear unconventional, combining established administrative arrangements with features of the market. In other words, governance arrangements are now often hybrid practices, combining administrative systems with market mechanisms and non-profit organizations (Bevir, 2013:6).

We agree with Fukuyama (2013:4) that fundamentally, governance is about the performance of agents in carrying out the wishes of principals. Hence, governance is about execution or what has traditionally fallen within the domain of public administration, as opposed to politics (Fukuyama, 2013:4).

Therefore, in considering the possibilities of enhancing the quality of governance in Nigeria, by increasing women participation in governance, it will be important to agree on who may be called the principals. The goals that the principals set are a function of whom they are. Ipso facto, the quality of governance is essentially dependent on the achievement of these goals.

Let it be immediately noted that currently, the contextual and empirical principals in governance in Nigeria are the Nigerian elite. Hence, the issue is critically more about elite pollution of governance than an issue of increased women participation as panacea. In this regard, it appears as if the era of unprecedented women participation in governance in Nigeria, has also been marked as an era of unprecedented corruption. There is no evidence in support of a position that governance challenges in Nigeria are mostly associated with men. In an era of increasing women participation in governance, there is no evidence in support of decreasing governance challenges such as corruption.

Nearly all the suffocating national challenges have remained unaddressed. In essence, a particular development that would have easily passed for an already addressed national challenge is the issue of the virtually disappeared queues at fuel stations in Nigeria. But basically, the queues were created by the avarice of the petroleum products-importing Nigerian elite. Now that the nefarious elite-importers and their other elite collaborators have ostensibly been dislodged, they went back to their dubious drawing boards, to devise the designs that have led to the irreconcilable NNPC remittances. This is happening in an era of a woman Minister of Finance and another woman as Petroleum Minister.

In its country reports on human rights practices for 2012, (United States' State Department, 2013), the United States' Bureau of Democracy, Human Rights and Labour, presents an empirical catalogue of national infractions and deficiencies in Nigeria, that depicted the Jonathan Administration as a political nonstarter. Section 4 of subject publication commences as follows: The

law provides criminal penalties for official corruption; however, the government did not implement the law effectively, and officials frequently engaged in corrupt practices with impunity. Massive, widespread, and pervasive corruption affected all levels of government and the security forces. This section of the report subsequently provided copious details of national prevarications on cases of corruption in Nigeria. For instance, it further highlights as follows: On April 18 (2012), a House of Representatives Committee led by Representative Farouk Lawan and charged with investigating the fuel subsidy program from 2009 to 2011 released a report showing massive fraud, corruption, and inefficiencies in the operation of the program. The report alleged misappropriation of nearly half the subsidy funds, with poor or nonexistent oversight by government agencies. The report estimated government money lost to “endemic corruption and entrenched inefficiency” amounted to 1.067 trillion naira (\$6.8 billion). The committee recommended reform of the oversight and enforcement mechanisms and further endorsed investigation and prosecution of culpable officials. In July the government released a list of those who had benefited illegally from the subsidy program, which included relatives and colleagues of key government officials. In late July the EFCC began arraigning suspects, first with a group of 20 indictments, including six oil companies and 11 individuals. By year’s end the EFCC initiated prosecutions of approximately 50 cases related to the subsidy scam. The majority of these cases involved companies and individuals who had fraudulently received subsidy revenue. Investigations and trials had not produced any convictions by year’s end. The Bureau of Democracy, Human Rights and Labour further highlights: On February 27, former Delta State governor James Ibori pled guilty to charges in the Southwark Crown Court in London to charges of money laundering and other financial crimes totaling 12.4 billion naira (\$79 million) he had committed during his eight years in office. On April 17, the court sentenced Ibori to 13 years in prison. Soon after the court announced Ibori’s conviction, the EFCC issued a statement it intended to pursue a case against Ibori in Nigerian courts (United States’ State Department, 2013).

Indeed, the rest of the publication contains a mind boggling reminder of cases of national impunities, masterminded by the Nigerian elite in the year 2012 alone. This was happening in an era of women ascendancy in governance in Nigeria. Therefore, the theoretical tastes of the increasing wave of women in governance in Nigeria remains remarkably bifurcated from the empirical situation.

Conclusion

Indeed, governance comprehensively refers to all processes of governing, whether undertaken by a government, market or network, whether over a family, tribe, formal or informal organization, or territory and whether through laws, norms, power or language (Bevir, 2013:1). To such extent, women have been participating actively in governance in Nigeria. Therefore, the portrait of women and governance in Nigeria is not as obscure as the women political elite in Nigeria.

The other truth is that corruption in Nigeria is generically elite propelled. There is insufficient evidence to successfully contend that it is only male-elite propelled. On the basis of our findings in this study therefore, we opine that the panacea for the menacing cases of corruption that has remained on the ascendancy in Nigeria can hardly be located within the horizon of increased women participation in governance. In essence, findings of the study suggest that the heartbeat of the panacea would be found more in the psychology and worldview of the generic Nigerian elite, which requires revolutionary remolding.

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