UNIVERSITY OF PORT HARCOURT JOURNAL OF ACCOUNTING AND BUSINESS
DEPARTMENT OF ACCOUNTING
UNIVERSITY OF PORT HARCOURT, CHOBA
PORT HARCOURT, RIVERS STATE
NIGERIA
VOL. 3 NO. 2 JUNE 2016

ESTIMATION OF MOTIVATION, USING ENTROPY

JONES OGHENEMEGA EJECHI PhD.
Department of Business Administration
Faculty of Management Sciences
University of Benin
Benin City.

And

IFUERO OSAD OSAMWONYI PhD.
Department of Banking and Finance
Faculty of Management Sciences
University of Benin
Benin City.

ABSTRACT

Man has continuously sought for the best way of doing things; including motivating and gauging the motivational level of its workforce. This study seeks for a more precise mathematical function (tested with empirical data) that can accurately measure the motivation of Nigerian universities.

We adapted Ejechi (2014[a])'s questionnaire, which we administered on three hundred and ninety six (396) academics of University of Benin, Benin City; retrieving 352 of the administered questionnaire to arrive at a response rate of 89%. This questionnaire had been found to be reliable using Cronbach's reliability test. We also modified Ejechi (2014[a])'s entropy model to arrive at M = $M_e + \sum_i p_i \, log \frac{1}{p_i}$. We used Ordinary Least Square (OLS); and established the adequacy of the model by considering its degree of fitness (R – Squared and Adjusted R – Squared) and the probability that the coefficient is zero (p value) at 95% level of confidence –same as comparing our calculated t – score (in this case z – score) with the critical value. We tested the null hypothesis and based our conclusion on the yard stick mentioned above.

We found that our modified model truly measures the motivation of academics in Nigerian universities. Total motivation is always positive and can never be zero, since the regression returned only positive coefficients and the intrinsic component of the total motivation is never zero. The need for self-actualization was found to be of utmost importance to academics, while social needs are the least important. We recommended that policy makers, government and university managements, should pay more attention to the self-actualization needs of academic staff. We also recommend that this study

Be replicated in other economic sectors in order to ascertain the relative sensitivity that may occur. We also recommend that this study be replicated, approximating our entropy model by variants of integral functions or Sine function.

INTRODUCTION

The desire to optimize socio-economic indices, for the well-being of man, has remained in the front burner of enquiries in virtually all fields of learning (philosophy, economics, management, engineering, management science and a host of others) for ages. Man has continuously sought for improved ways, or the best way, of doing things. To be able to appraise the amount of improvements made or being made on a phenomenon, there is the need tomeasure, gauge or estimate three fundamental properties of the phenomenon under consideration (in this case, motivation): the initial state, the ongoing state and the desired state (destination). Besides, the more accurate our measurements are, the better informed our decisions would be (Rubin, 1968; Rubin, 1971; Hacking, 1975;&Post, 1990). Kaplan and Norton (1996:21) noted that, "if you can't measure it, you can't manage it."

Of all the factors of production in any organization labour, or more appropriately human resources, is the most important. And you can only get the best out of people when they are sufficiently motivated and/or are satisfied with their jobs. Motivation is believed to be the secret of the Japanese's amazing economic success in recent times (Ejechi, 2014). People – not technology alone or marketing ploys – are the keys to success in global competitions (Hoerr, 1989; Kreitner, 1992 & Abbass, 2012). As Bessell, Dicks, Wysocki and Kepner, (2002:1) puts it, "Managers use motivation in the workplace to inspire people to work, both individually and in groups, to produce the best results for business in the most efficient and effective manner".

Up till now, however, the measurement or estimation of the motivation of workers is still being approximated at ordinal level of measurement. Only few empirical studies have captured the motivation of workers at interval or ratio levels of measurement. With all the research works done on motivation, we do not have a universally acceptable model or function that precisely measures the motivation of workers. Indeed, for a very long time Vroom's Expectancy model (Vroom, 1964), which derives from the earlier works of Lewin (1938) and Tolman (1959), was the only theory of motivation that applied a resemblance of mathematics, a precision science, in the measurement of motivation (Kotliarov, 2006). The works of Porter and Lawler (1968) and Lawler (1972) were only extensions of the expectancy theory.

Credit must however be given to Srivastava and Kakkar(2008), who attempted to estimate motivation using entropy. However, besides the fact that they based their findings on hypothetical data, their application of Shannon's model of entropy is fraught with a lot of errors. The need for a more precise mathematical function (tested with empirical data) that can accurately measure the motivation of workers can therefore not be over emphasized. It is the humble goal of these researchers to fill this yearning gap.

LITERATURE REVIEW

In this our modest attempt at shedding some lights on the concept and measurement of this all-important phenomenon of all times, motivation; while focusing on Srivastava's Shannon entropy model, we noted that the concept finds expression in many fields of enquiry like Organizational Behaviour, Economics, Psychology, Sociobiology, Anthropology, Sociology, Political Science, Medicine and a host of others. Motivation has been, and will always remain in the front burner of enquiries because of the cardinal role that it is believed to play in the achievement of set goals and success generally, whether personal or organizational.

The multidisciplinary nature of the enquiries into the study of motivation has contributed to the so many definitions of, and views about motivation, that Kleinginna and Kleinginna (1981) gathered 102 different definitions and critical views of motivation (Petri, 1991). We however aligned ourselves with the modified form of the definition given by Davis and Palladino (2004) and thus define motivation as the physiological and or psychological process (es) /factor(s) which having caused our purposeful behaviour to be aroused; directs, intensifies and sustains it.

We accept the fact that the various theories of motivation have been influenced by the varying backgrounds, academic disciplines and philosophical views of the different proponents. However, we consider the various groupings of motivational theories to be useful, only for ease of analysis and pedagogy; and thus think that each work should be considered on its own merit. Despite the battering that Maslow's Hierarchy of Needs Theory has received, it can still be adjudged to have received the widest recognition, particularly among practicing managers. This, according to Robbins (2003), can be attributed to the theory's intuitive logic and the ease of understanding. Indeed, Srivastava and Kakkar (2008) anchored their Shannon entropy model on it. Douglas McGregor's theory X and theory Y, revealed in his 1960 classic, The Human Side of Enterprise, has been considered as a major contribution to the development of Organizational Behaviour. It was Frederick Herzberg who discovered a new fact about motivation. The general belief before then was that the same set of factors was responsible for motivation or the lack of it. We must quickly point out at this time, however, that this view has not been corroborated by modern empirical evidences.

Clayton Alderfer's reworked version of Abraham Maslow's Hierarchy of Needs theory, the ERG theory, may be considered a response to the criticisms of the Maslow's work. This theory, which belongs to the same category in many respects as the Maslow's (they both belong to the content theories, biological theories and nomothetic research view), has received appreciable support and validation. It is believed to have been aligned more closely with the empirical research. McClelland's Acquired Needs Theory, unlike Maslow's Hierarchy of Needs theory, believes that the interaction between individual needs and the environment leads to the development or acquisition of three kinds of needs in every individual, at any point in time. This theory brings to the fore the role of culture and environment in motivation.

We have adopted Srivastava and Kakkar's Shannon entropy model as our major focus in this study. This model is unarguably the most mathematical explanation of motivation in contemporary times. However, it is fraught with glaring shortcomings. Srivastava and Kakkar

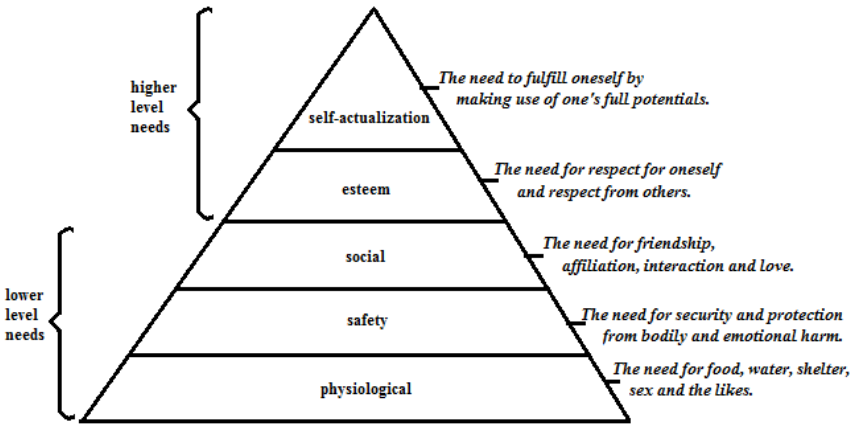
(2008) had applied Shannon's entropy formula on Maslow's hierarchy of needs theory without establishing or ensuring that they were operating with proper probability distribution, which is sine qua non, as it was stipulated by Shannon (1948). Beside the fact that Srivastava and Kakkar (2008) were not based on empirical evidence, they also arbitrarily assigned quantitative values to some variables in Maslow's hierarchy of need theory without justification.

We have stated that by the 1950s, several new models of work motivation emerged, which collectively have been referred to as content theories, since their principal aim was to identify factors associated with motivation. The major proponents included Maslow's (1954) need hierarchy theory, McClelland's 1987 theory of needs and Herzberg's (1966) two-factor theory. We also stated that Shannon's entropy model of Srivastava and Kakkar (2008) was predicated upon Maslow's hierarchy of needs theory. Thus, using Srivastava and Kakkar (2008) model as a guide, we took Maslow's Hierarchy of Needs' theory to a new mathematical level.

Hierarchy of Needs Theory

Abraham Maslow postulated that every human being has five levels of needs, arranged in a hierarchical order. These needs are Lower Level Needs (physiological needs, safety needs and social needs) and Higher Level Needs (esteem and self-actualization). Greenberg and Baron (2003:192) had observed that the five needs identified by Maslow correspond with the three needs of Alderfer's 1972 ERG theory. The hierarchies have also been expanded to eight levels. They are: Biological and Physiological needs (basic life needs - air, food, drink, shelter, warmth, sex, sleep, etc.); Safety needs (protection, security, order, law, limits, stability, etc.); Belongingness and Love needs (family, affection, relationships, work group, etc.); Esteem needs (achievement, status, responsibility, reputation); Cognitive needs (knowledge, meaning, self-awareness); Aesthetic needs (beauty, balance, form, etc.); Self-actualization (personal growth, self-fulfillment) and Transcendence (helping others to self-actualize) (Chapman, 2001:7). We shall however limit ourselves to the original five levels of Maslow, as depicted in figure 1.

FIG. 1: MASLOW'S FIVE-LEVEL HIERARCHY OF NEEDS



Source: Adapted from Ivancevich and Mettesson (1999).

The basic assertions of Maslow include the following:

(a) That the five human needs are arranged in a hierarchical order (Maslow, 1943). Lower level needs are more important to the individual and must be significantly satisfied before the individual can begin to think of satisfying other higher level needs in the hierarchy. For instance, a junior worker who is still grappling with his basic needs of food, clothing, shelter and the likes would not bother about whether or not his organization affords him the opportunity to use his initiative. He would not also be concerned about his safety and esteem. Maslow had argued that as soon as a lower level need is sufficiently satisfied, the individual's focus is shifted to an immediate higher level need in the hierarchy.

(b) That a need ceases to be a motivator as soon as it is sufficiently satisfied. According to him, a worker who perceives that he is adequately remunerated for his job in the organization may no longer see increase in wage as a motivator. He then counseled that the increase in the salary of such a person would amount to flogging a dead horse.

(c) Maslow also assumed that every individual has a desire to grow and thus would like to progress from the basal physiological need to the highest need of self-actualization. He even went further to postulate that the average adult has satisfied about 85% of the physiological needs, 70% of safety needs, 50% of social needs, 40% of esteem, and 10% of self-actualization (Ivancevich & Matteson, 1999:151).

Research findings (Porter, 1963; Ivancevich, 1969) do not however support or validate the theory. For instance, the work done by Porter (1961) could not support the existence of a precise five-level hierarchy of needs. He also discredited Maslow's postulation which said that human needs are arranged in a hierarchical order, from the most important lowest level physiological need to the highest level need of self-actualization. Schermerhorn, Hunt and Osborn (1997) believes that there is no fixed hierarchy and that the choice of the individual with respect to what needs to satisfy varies with position in organization, size of the organization, geographical location and indeed culture.

ENTROPY MODEL

The entropy model, credited to Srivastava and Kakkar (2008), applied to Maslow's and McClelland's motivation models a modified thermodynamic principle of entropy, called Shannon's entropy. An earlier work had been done by Shannon (1948) where he used the principle of entropy to estimate the value of information, in his paper titled "A mathematical theory of communication".

They stated that motivation (Mot) is given by

$$\mathrm{Mot} = \log\{\sum_{i=1}^{3}(B_i)\},\ 0 \le B_i \le +1 \qquad (1)$$

where B_i are probabilities of some partial motivation variables like the Maslow's motivation indices (Srivastava & Kakkar, 2008:55).

The first implication of leaving their formula the way it is stated is that we could have negative values for motivation, which their findings did not suggest. Given B_i, such that $0 \le B_i \le +1$, $\Rightarrow \sum_{i=1}^{3}(B_i)$ could still be a fraction of the form $\frac{b}{c}$ where $b<c$ and $\log b<\log c$. This

Follows that$\log\left(\frac{b}{c}\right) = \log b - \log c < 0$. However, whereas the formula is not enclosed within any modulus sign, the results of the application of their formula returned only positive values, even for cases where the value ought to be negative. The second implication arises directly from the first; that is, they didn't expect negative values. Therefore, they must have implied that their formula carried a modulus sign. Again, this means that motivation must be positive, in line with the position of Kotliarov (2006). There is yet another problem with the work of Srivastava and Kakkar (2008). Whereas they properly applied Shannon's formula in their final solution:

$\text{Mot} = \log\{\sum_{i=1}^{3}(B_i)\} = \log(N_b) + \log(P_b) + \log(R_b)$ (2)

where N_b, P_b and R_b are probabilities of some partial motivation indices; which in this case stand for need-based, process-based and reinforcement-based motivations respectively; and $H(N_{b,}N_{b.}N_b) = \log(N_{b,}N_{b.}N_b)$, they failed to apply the same principle when they computed the contributions of the Maslow's motivation variables. Here, they strangely simply multiplied their assumed contributions (which are probabilities) without even ensuring that these variables are independent. In any case, equation 2 above is not Mathematics! $\log\{\sum_{i=1}^{3}(B_i)\} = \log\{B_1 + B_2 + B_3\} \neq \log(B_1) + \log(B_2) + \log(B_3)$. The need to fine-tune their methodology has therefore become imperative. We intend to start by taking a second look at the Shannon's entropy principle, from its mathematical definition.

Let X be a random motivation variable with distribution p(X). To quantify the motivation provided by each possible outcome, or to find a function which maps the probability of an event p(x) to the motivation M(x), we would have the following properties:

$M(x_i) \geq 0 \forall\, i$ (3)

Notice that if x_i are motivation factors, then$(x_i) \geq 0$, $\forall i$. If $p(x_i)$ is the probability of achieving x_i, then the more difficult it is to obtain x_i the more rewarding or motivating it would be. The more uncertain a proposed reward is, the more motivating it would be. This agrees with the uncertainty process theory of motivation propounded by Anselme (2010) and by Anselme; Robinson and Berridge (2013). Uncertainty processing theory asserts that motivation, being a mental process that seeks to reduce the uncertainty of a "psychologically significant event" in an individual, is an information-seeking behaviour. Put another way, uncertainty processing theory redefines motivation as a means by which an individual seeks to guarantee a certain outcome. Michael (2013) contended that without some degree of uncertainty, motivation cannot occur. This means that the probability must of necessity be strictly less than one. However, for our motivation to be defined we must not be absolutely uncertain; the probability must be strictly greater than zero. This implies that the probability must lie between zero and one, $0 \leq p(x) \leq 1$. Michael (2013: 197) again stated that our actions and behaviours are basically guided by a desire to reduce the uncertainty associated with receiving the promised incentive. According to him, it was found that "reward uncertainty" triggered dopamine production in the brain and a corresponding physical response, and without the uncertainty, dopamine production was suppressed.

Thus

$M(x_1) > M(x_2)$ if $p(x_2) > p(x_1)$. (4)

And

$M(x_1.x_2) = M(x_1) + M(x_2)$iff x_1 and x_2 are independent. (5)

M(x) =f (p(x)) (6)

We would therefore require a function f ( ) that will satisfy the condition that $M(x_1.x_2) = M(x_1) + M(x_2)$. the only function that has this property is logarithm. Recall that

$\log(a.b) = \log a + \log b$. Therefore we define $M(X) = \log(\frac{1}{p(x)})$ (7)
The above is subject to $0<p(x)<1$.

Assume we have a sequence of observations of the random motivation variable X; we would want to find the average value of motivation per observation. This quantity, according to Downey (2013), is called Entropy and is denoted by H(X) which is given below:

$H(X) = E\left[\log(\frac{1}{p(X)})\right]$ (8)

Notice that whereas motivation is associated with an event, entropy is associated with a distribution over events, $p(X)$. For example, in the toss of a fair coin,

$H(X) = E[I(X)] = \sum_i p(x_i)\ I(X)$

Thus the amount of motivation provided per event is given as: $M(p_i) = p_i \log \frac{1}{p_i}$ (9)

Subject to the condition that, $0<p(x)<1$.

Here, motivation must be positive and the formula is as shown below:

Motivation, $\sum_i M(x_i) = \sum_i p_i \log \frac{1}{p_i}$ (10)

So that total motivation, $M = M_e + \sum_i p_i \log \frac{1}{p_i}$ (11)

Where M_e (a constant, which must be discounted by dividing the resulting figure by n, the number of events) is the intrinsic motivation component and $p_i\ \forall$ i: $1 \leq i \leq n$are the

Probabilities of the Maslow's motivation variables. Notice that n in this case is 5. Thus, $p_i \; \forall \, i$: $1 \leq i \leq 5$.

Stated as in equation (11), the model has three unique features: it will only return positive values for motivation, in line with Kotliarov (2006) and Srivastava and Kakkar (2008). {Recall that$\log \frac{1}{p_i} = \log 1 - \log(p_i) = 0 - \log(p_i)$. Now p_i is a fraction of the type$\frac{b}{c}$, where b<c andlogb<logc. Since $\log(p_i) = \log b - \log c$,it implies that$\log(p_i)$<0. Therefore,$\log \frac{1}{p_i} = 0 - \log(p_i)$>0}. The model also included the intrinsic component of motivation, a germane component of motivation which was overlooked by Srivastava and Kakkar (2008). Another beauty of this model is that it can be applied using different models of motivation, where we intend to obtain the cumulative contributions of all the variables of motivation. In this case we will consider motivation as the aggregate of the contributions of all the Maslow' variables, as obtained in Srivastava and Kakkar (2008).

METHODOLOGY

Rather than base our findings on hypothetical data like Srivastava and Kakkar (2008), we adapted Ejechi (2014[a]) questionnaire. We administered this on three hundred and ninety six (396) academics of University of Benin, Benin City; retrieving 352 of the administered questionnaire to arrive at a response rate of 89%. In establishing the internal consistency of the research instrument, Ejechi (2014[a]), who administered his questionnaire to four hundred and two (402) academics drawn from six universities from the South South Geopolitical Zones of Nigeria, had subjected the questionnaire to Cronbach's reliability test in six tranches; resulting in the Cronbach's alpha figures of 0.806, 0.879, 0.788, 0.851, 0.807 and 0.871). And, based on Dawson and Trapp (2001), he gave a verdict of very good to the general reliability of the research instrument.

We also modified Ejechi (2014[a])'s model. In assessing our modified entropy model; M = $M_e + \sum_i p_i \log \frac{1}{p_i}$, where M_e is the intrinsic motivation component and $p_i(\forall i)$ are theprobabilities of the Maslow's motivation variables such that $\sum_i p_i = 1$, we used Ordinary Least Square (OLS). And we established the adequacy of the model by considering its degree of fitness (R – Squared and Adjusted R – Squared) and the probability that the coefficient is zero (p value) at 95% level of confidence - same as comparing our calculated t – score (in this case z – score) with the critical value. We tested the null hypothesis and based our conclusion on the yard stick mentioned above.

HYPOTHESIS

H_0: The modified entropy model does not measure the motivation of academic staff of Nigeria universities.

TEST OF HYPOTHESIS

Here, we presented and considered a single hypothesis. We judged its acceptability or non-acceptability (acceptance or rejection) on the basis of the result emanating from the analysis of the observed data.

Our modified entropy model is given as, $M = M_e + \sum_i p_i \log\frac{1}{p_i}$, (11)

Where M_e (a constant) is the intrinsic motivation component and the $p_i \forall i: 1 \leq i \leq 5$are theprobabilities of the Maslow's motivation variables. Decomposing further, we arrived at: $\sum_i p_i \log\frac{1}{p_i} = p_1\log\frac{1}{p_1} + p_2\log\frac{1}{p_2} + p_3\log\frac{1}{p_3} + p_4\log\frac{1}{p_4} + p_5\log\frac{1}{p_5}$. Note that p_i (in equation 11) = p(pi), $\forall : 1 \leq i \leq 5$in Table 1. While p_i is a probability, pi is a percentage or a proportion (refer to Table 1).

Thus, the actual variables, $\forall$ i: $1 \leq i \leq 5$, in our Multiple Regression Analysis are:
M_1= PARTIALM1= Martial motivation based on Maslow's variable 1 = p(p1)*log(1/p(p1))
M_2= PARTIALM2= Martial motivation based on Maslow's variable 2 = p(p2)*log(1/p(p2))
M_3= PARTIALM3= Martial motivation based on Maslow's variable 3 = p(p3)*log(1/p(p3))
M_4= PARTIALM4= Martial motivation based on Maslow's variable 1 = p(p4)*log(1/p(p4))
M_5= PARTIALM5= Martial motivation based on Maslow's variable 1 = p(p5)*log(1/p(p5))

Table 1 Operationalization and measurement of variables

Variable name	**Variable**	**Variable source**	**Calculation technique**	**Remark (level of measurement)**
Maslow's variables	p_1	Physiological needs	$p_1 = p(P_1)$, $P_1 = P_1/(P_1+P_2+P_3+P_4+P_5)$	Standardized ratio, ensuring proper pdf.
	p_2	Safety needs	$p_2 = p(P_2)$, $P_2 = P_2/(P_1+P_2+P_3+P_4+P_5)$	
	p_4	Social needs	$p_4 = p(P_4)$, $P_4 = P_4/(P_1+P_2+P_3+P_4+P_5)$	
	p_5	Esteem needs	$p_5 = p(P_5)$, $P_5 = P_5/(P_1+P_2+P_3+P_4+P_5)$	
	p_3	Self-actualization	$p_3 = p(P_3)$, $P_3 = P_3/(P_1+P_2+P_3+P_4+P_5)$	
Partial	M_1	Partial	= p(p1)log(1/p(p1))	Ratio scale, returning

motivations	M_2	motivations, based on Maslow's variables (p_i)	= p(p2)log(1/p(p2))	only positive results.
	M_3		= p(p3)log(1/p(p3))	
	M_4		= p(p4)log(1/p(p4))	
	M_5		= p(p5)log(1/p(p5))	

DATA ANALYSIS

Below is the result of the Multiple Regression of the modified entropy model, with total motivation (MT) as the dependent variable and independent variables (M_i), as stated above. MT is total motivation; M_1, M_2, M_3, M_4, and M_5 are partial motivations resulting from the satisfaction of Maslow's physiological needs, safety needs, self-actualization, social needs and esteem needs, respectively; and ser and R^2 are Standard Error of Regression and R- Squared, respectively. While the coefficients ($\alpha = 125.2,\ \beta = 119.8,\ \gamma = 173.7,\ \rho = 34.7$ and $\omega = 107.2$) represent the relative impacts that the Maslow's variables exert on the motivation of academics in Nigerian universities, C = 18.14 (90.65713/5; the intercept and a constant) represents the intrinsic motivation component of the total motivation, which in this study is constant. The implication is that an average academic of the Nigerian universities has a constant intrinsic motivational level of about 18%, albeit poor. This is irrespective of whether or not his needs are met.

TABLE 2. REGRESSION RESULT OF THE MODIFIED ENTROPY MODEL

Dependent Variable: MT
Method: Least Squares
Date: 13/03/15 Time: 13:11
Sample: 1 352
Included observations: 352

Variable	Coefficient	Std. Error	t-Statistic	Prob.
M_1	125.1593	21.22129	5.897818	0.0000
M_2	119.7760	10.01142	11.96394	0.0000
M_3	173.6641	13.93243	12.46474	0.0000
M_4	34.73886	11.01450	3.153921	0.0017
M_5	107.2014	17.50715	6.123290	0.0000
C	90.65713	13.18348	6.876570	0.0000

R-squared	0.405419	Mean dependent var	64.05625
Adjusted R-squared	0.397874	S.D. dependent var	10.32130
S.E. of regression	8.008995	Akaike info criterion	7.013894
Sum squared resid	25272.74	Schwarz criterion	7.073766
Log likelihood	-1396.779	Hannan-Quinn criter.	7.037604
F-statistic	53.73037	Durbin-Watson stat	2.011526
Prob(F-statistic)	0.000000		

Thus, with respect to our null hypothesis which states that "the modified entropy model does not measure the motivation of academic staff of Nigeria universities", the summary of the regression result between total motivation (MT) and the independent variables of our modified model is:

$$MT = C + \alpha M_1 + \beta M_2 + \gamma M_3 + \rho M_4 + \omega M_5$$

$$MT = 18.14 + 125.2M_1 + 119.8M_2 + 173.7M_3 + 34.7M_4 + 107.2M_5, \text{ ser=8.0089, } R^2 = 0.4054)$$

(13.1) (21.2) (10.0) (13.9) (11.0) (17.5)

This shows the degree of fitness of the model to be relatively significant, at (R^2 = 0.4054). At 99.9% level of confidence, with p = 0.0000, the null hypothesis that all the coefficients are zeroes was rejected. Again, we rejected each of the null hypotheses, at 99% level of confidence, that any of $\alpha, \beta, \gamma, \rho$ or ω is zero, with the p values given as: 0.0000, 0.0000, 0.0000, 0.0017 and 0.0000. We therefore rejected the null hypothesis which states that "The modified entropy model does not measure the motivation of academic staff of Nigeria universities" and concluded that our modified model truly measures the motivation of workers.

On the possibility of autocorrelation, the result shows the Durbin-Watson statistic to be 2.011526, which rules out the possibility. Another implication of a good Durbin-Watson statistic is that, it shows the model to be appropriate for the kind of data analysed. Fitting a linear function on a quadratic data, for instance, will result in a poor Durbin-Watson figure less than 0.8.

The fact that the intrinsic component of the total motivation (C = 18.14) is not zero also suggests that total motivation can never be zero. Again, the result of the multiple regression, which returned positive values confirmed the argument of Ejechi (2014[a]) that motivation is always positive. This corroborates the works of Kotliarov (2006) and Srivastava and Kakkar (2008).The coefficients of Maslow's Social need ($\rho = 34.7$) and Self actualization ($\gamma = 173.7$)are the least and the highest respectively. This suggests that, whereas, social needs is the least concern of an average Nigerian university academic, his greatest source of motivation is self actualization. This further goes to show that most academics in Nigerian universities have been able to satisfy their lower level needs to a great extent; hence their motivation is now hinged on higher level needs (Maslow, 1943 & 1954).

CONTRIBUTIONS TO KNOWLEDGE

In the course of this work, we made the following contributions to knowledge:

We have been able to ameliorate the shortcomings of Srivastava and Kakkar's entropy model of 2008 by; (a) including the criterion that the probability density function (pdf) in use must be proper ($\sum_i p_i = 1$) - in line with the principle of entropy, (b) including the intrinsic component of motivation into the model, and (c) guaranteeing the non-negativity of motivation, in our modified entropy model. To the best of our knowledge, no other study has

Observed or corrected these shortcomings in entropy model of motivation. Indeed, this is the first empirical study that applied entropy to the measurement of the motivation of academic staff of Nigeria universities.

CONCLUSION AND RECOMMENDATIONS

From the results and findings of this study the following conclusions have been reached: Our modified model truly measures the motivation of academics in Nigerian universities. We also safely concluded that total motivation is always positive and can never be zero since the regression returned only positive coefficients and the intrinsic component of the total motivation is never zero. Judging by Maslow's theory, the social needs is the least concern of an average Nigerian university academic, his greatest source of motivation is self-actualization. This further goes to show that most academics in Nigerian universities have been able to satisfy their lower level needs to a great extent; hence their motivation is now hinged on higher level needs.

We recommended that policy makers, government and university managements, should pay particular attention to the self actualization of academic staff. This they can achieve through ensuring the good working condition, promotion and growth; good pay and job security of academic staff of universities in Nigeria. Half of the motivation-related problems of academic staff of universities in Nigeria, and by extension ASUU, would be settled if this singular need is guaranteed.

Arising from the very wide nature of the subject of motivation and the existence of a plethora of other salient determinants of behaviour in organizations generally, we were careful not to be over ambitious, and so limited the focus of this study to the estimation, in quantitative terms, of the motivation of academic staff of universities in Nigeria. There are therefore many areas that could make the knowledge in this sub-field much more robust. We thus recommend further studies that would dig out other determinants of motivation and X-ray the links between the classifications of demographic variables and motivation. We also recommend that this study be replicated in other economic sectors in order to ascertain its relative sensitivity.

Finally, we want to state with a great sense of modesty and resignation that there are sufficient reasons to suppose that alternative decisions are not always dichotomous or discrete, as we made it look in this study; but many times continuous, or even cyclic (as in trends). The implication is that motivation may thus be better captured using integral or even sine functions that are continuous in nature. This is an area we think should be further researched into. We therefore recommend that this study be replicated by approximating our entropy model by variants of integral functions or sign functions.

REFERENCES

Abbass, I. M. (2012). Motivation and local government employees in Nigeria. European Scientific Journal, 8(18) 129-141. Retrieved 12/03/2014 from http://www.eujournal.org/index.php/esj/ article/view/290.

Alderfer, C. P. (1972). Existence, relatedness and growth: human needs in organizational settings. New York: Free Press.

Anselme, P. (2010). The uncertainty processing theory of motivation. Behavioural Brain Research, 208 (2) 291-310.

Anselme, P.; Robinson, M. J. F. and Berridge, K. C. (2013). Reward uncertainty enhances incentive salience attribution as sign-tracking. Behavioural Brain Research, 238 53-61.

Bakker, A. (2003). "The Early History of Average Values and Implications for Education." Journal of Statistics Education, 11, (1). Retrieved 17/05/2014 from www.amstat.org/ publications/jse/v11n1/bakker.html

Bessell, I., Dicks, B., Wysocki, A., & Kepner, K. (2002). Understanding motivation: An effective tool for managers (IFAS No. HR017). Florida, University of Florida, Food and Resource Economics Department.

Chapman, A. (2001). Eight levels of needs based on Maslow's hierarchy of needs. Retrieved 22/07/2014 from www. businessballs.com

Ejechi, J. O. (2014). Mathematical models of motivation: A test of the expectancy hypothesis. An unpublished PhD Seminar paper.

Ejechi, J. O. (2014[a]). Motivation of academic staff of universities in Nigeria: A quantitative approach. An unpublished PhD Thesis of the University of Benin, Benin City.

Greenberg J &Baron A.R (2003). Behaviour in Organisations. Prentice Hall, Vol. 8, pp. 188-215

Hacking, I. (1975). The Emergence of Probability: A Philosophical Study of Early Ideas about Probability, Induction and Statistical Inference. Cambridge: Cambridge University Press. Cited in Bakker (2003).

Herzberg, F. (1968). One more time. How do you motivate employees? Harvard Business Review, 46, 53-62.

Hoerr, J (1989). The payoff from teamwork. Business Week, July 10th Issue (36 – 50).

Ivancevich, J. M. & Metteson, M. T. (1999). Organizational Behaviour and Management. Boston: Irwin/ McGraw-Hill.

Kaplan,R. S. & Norton, D. P. (1996). Translating strategy into action: The balanced scoreboard. Boston, Massachusetts: Harvard Business School Press.

Kleinginna, P. R. & Kleinginna, A. M. (1981). A Categorized list of motivation. Definitions, with a suggestion for a consensual definition. Motivation and emotion, 5, 263-291.Cited in Petri (1991).

Kotliarov, I. (2008). Mathematical formalization of theories of motivation proposed by Maslow and Herzberg. Fractal: Revista de psicologia. 20 (2), 341-346.

Kotliarov, I. (2006). Mathematical modeling of human motivation: A vector hypothesis. Panorama Socio economico Ano. 24 (33), 66-74.

Kreitner, R. (1992). Management (5th ed.) Boston: Houghton Mifflin Company.

Lawler, E. E. (1973). Motivation in Work Organizations. Monterey, California: Brooks/ Cole Publishing.

Lewin, K. (1938). The conceptual representation and the measurement of psychological forces. Durham, NC: Duke University Press, cited in Steers, Mowday & Shapiro (2004).

Maslow, A. H. (1943). A Theory of human motivation. Psychological Review, July, 370-396.

McClelland, D.C. (1987). Human motivation. Cambridge: Cambridge University Press.

Maslow, A. H. (1954). Motivation and personality. New York: Harper & Row.

Michael, A. (2013). Uncertainty and motivation. Behavioural Brain Research April, 192-205.

Petri, H. L. (1991). Motivation: Theory, research and applications, (3rd ed.) California: Brooks/Cole Publishing Company.

Porter, L. W. (1961). A study of perceived need satisfaction in bottom and middle-management jobs. Journal of Applied Psychology. February, 1-10. Cited in Ivancevich & Metteson (1999).

Porter, L. W. and Lawler, E. E. (1968). Managerial attitude and performance. Homewood, Ill: Irwin-Dorsey.

Rubin, E. (1971). Quantitative Commentary on Thucydides. The American Statistician, 25(4), 52-54. Cited in Bakker (2003).

Rubin, E. (1968). The Statistical World of Herodotus. The American Statistician, 22(1), 31-33. Cited in Bakker (2003).

Schermerhorn, J. R., Hunt, J. G. & Osborn, R. N. (1997). Organizational Behaviour (6th ed.) New York: John Wiley and Sons, Inc.

Shannon, C. E. (1948). A Mathematical Theory of Communication. The Bell System Technical Journal,27, 379–423, 623–656.

Srivastava, S. K. & Kakkar, D.N. (2008). Estimation of motivation using entropy. Journal of Business Economics and Management, 9 (1) 53-56.

Steers, R. M.; Mowday, R. T. & Shapiro, D. L. (2004). Introduction to special topic forum: The future of work motivation theory. Academy of Management Review, 29, (3), 379–387

Tolman, E. C. (1959). Principle of purposive behaviour. In Koch, S. (Ed.), Psychology: A study of science, 2, 239 – 261. New York: McGraw Hill cited in Steers, Mowday & Shapiro (2004).

Vroom, V. H. (1964). Work and motivation. New York: John Wiley.