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Impact of nanotechnology in nigeria: a short survey

Abstract

Nanotechnology, one of the foremost alternative modern technologies of the twenty-first century offers enormous benefits and opportunities through synthesis, characterization and fabrication of quite vast number of nanomaterial to solve societal immediate problems. Structured questionnaires were administered to three different industries in each of the six geo-political zones in Nigeria, a Country located in West Africa bordering the gulf of Guinea, Niger and Chad (North), Benin (West) and Cameroon (East) to determine the impact of nanotechnology. The data emanating from this study were analyzed using multiple regression analysis, correlation analysis, analysis of variance (ANOVA)[1] and likert 5 scales with T-test utilized in determining levels of significance. The findings are reported and discussed.

Keywords: nanotechnology, impact, nanomaterials, societal problems

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Introduction

Nanotechnology a term coined by K Eric Drexler in 1992[2] refers to manipulation of matter (with at least one dimensional size) from 1 to over 100 nanometer size to create new properties. All materials in nanoscale sizes are referred to as nanomaterials. They have quite a large surface area to volume ratio. This single characteristic paves way for new quantum mechanical effects and provides tremendous driving force for diffusion at elevated temperature.

Types of carbon nanomaterials

There are two types of Carbon nanomaterials

Fullerenes: These are a class of allotropes of carbon which conceptually are graphene sheets rolled into tubes or spheres. They include carbon nanotubes or silicon nanotubes. They are of interest because of their mechanical strength and electrical properties. Common fullerenes include Bucky ball clusters (found in soot or coal), Nanotubes or cylindrical fullerenes, Mega tubes, 2D and 3D polymers and Nano-onions.[3] The transition of these materials is from Fullerenes to Nanotubes and most recently to Graphenes.[4]

Nanoparticles: These are inorganic nanomaterials. They are made from metals, semiconductors and other particles that have great chemical, physical, electrical and magnetic properties e.g Quantum dots, Nanowires, Nanorods Clay nanoparticles, Titanium dioxide nanoparticles, Zinc oxide nanoparticles, Nanoparticles of yellow gold and Nanoparticles of gray Silicon.[4–6] Basically two kinds of Carbon nanoparticles exists-nano diamond and Carbon onions.

Applications of nanotechnology

i. Fullerenes find application in the medical field because of their ability to bind certain types of anti-biotics to the structure of resistant bacteria.

ii. Nanotubes have potential application in electrical industry.

iii. Mega tubes are mostly used in transport of variety of molecules having different sizes.[5]

iv. Nano-onions are proposed for lubricants.

v. Nanoparticles find its main application in production of chemical catalysts.

vi. Nanoparticles also find application in thermal therapies for Cancer.[7] Gold nanorods, Gold nano cages and Carbon nanotubes are being tested in vitro and in vivo to target tumor cells.[8]

vii. Nanoparticles are used in biomedical applications as drug carriers and imaging agents.

viii. Nanoparticles are used in optoelectronics.[6]

ix. Nanoparticles have also been attached to textile fibres in order to create smart and functional clothing.[9]

x. Clay nanoparticles when incorporated into polymer matrices increase reinforcement, leading to stronger plastics-hardnoparticles.[9]

xi. Liposomes {prototype semi-solid and soft nanoparticles} are currently used clinically as drugs/vaccine delivery systems.[7]

xii. Nanomaterials are employed in nuclear accident clean up.

xiii. Nanomaterials are also employed in reduction of energy consumption

xiv. Consumer products: With nanoparticles in consumer products,

A. Car bumpers are made lighter.

B. Clothing is more stain repellent.

C. Sunscreen is more radiation resistant.

D. Synthetic bones are stronger.

E. Cell phone screens are lighter weight.

F. Glass packaging for drinks leads to longer shelf life.

G. Balls for various sports are made more durable.

Nanotechnology and biosensor research

Nanotechnology is having a profound effect on the development of new biosensor. Biosensor comprise a biological molecule immobilized into the surface of a signal transducer to give a solid state. Analytical device. There are two major areas where nanotechnology has drastically impacted on biosensor research in the last two years. One is Nanofabrication of biosensing interface, two is application of new materials to biosensoring.[10]

Aim of study

The aim of this study is to investigate the impact of nanotechnology in Nigeria.

Method

This work involves the administration of structured questionnaire to three industries that utilize nanotechnology in each of the six geo-political zones in Nigeria. Primary data were generated from the questionnaire while secondary data were obtained from journals, electronic sites and other relevant materials. Two Hundred and Seventy Questionnaire for each zone, Forty-five Questionnaire for each state and Fifteen Questionnaire each for each industry in each state. The method of data analysis employed are Multiple Regression Analysis, Correlation Analysis, Analysis of Variance (ANOVA) with T-test utilized in determining level of significance.

Multiple regression analysis

Using this statistical technique, the relationship model was specified as follows:

$$Y = b_0 + b_1 x_1 + b_2 x_2 + \ldots\ldots\ldots b_n x_n \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where e=0 and b1 ..... b_n are parameters referred to as regression coefficients

This study has four independent variables and one dependent variable. The dependent variable is impact of nanotechnology denoted by Y while the independent variables include:

X_1: Health

X_2: Environment

X_3: Society

X_4: Speculative Issues

Correlation analysis

This was used to determine the degree of relationship between the dependent variable (Y) and independent variable (X_1 to X_4).

Correlation coefficient r ranges from the value of – 1<r<+1 given that

$$r = \frac{N\sum xy - (\sum x)(\sum y)}{\sqrt{[N\sum x^2 - (\sum x)^2][N\sum y^2 - (\sum y)^2]}} \sum x^2 \quad (2)$$

Where

N: Number of pairs of scores

∑xy: Sum of the products of pairs of scores

∑x: Sum of x scores

∑y: Sum of y scores

$\sum x^2$: Sum of squared x scores

$\sum y^2$: Sum of squared y scores

Analysis of variance (ANOVA)

This was used to obtain the statistical mean between the six zones in Nigeria.

Standard error of estimate (SE)

Standard Error of estimate (SE), a measure of the variation from the mean is competed using the

$$S_{xy} = \sigma y\sqrt{1-r^2} \quad (3)$$

$$S_{yx} = \sigma x\sqrt{1-r^2} \quad (4)$$

$$S_{yx} = \sqrt{\frac{\sum Y^2 - a\sum Y + b\sum YX}{N-2}} \quad (5)$$

Where

Y: Actual values

Ye: Estimated values

Decisions rule

The decision rule is to reject the null hypothesis if the probability of obtaining the value of T-test of a given extreme magnitude is greater than 0.05 or equal 0.01 level of confidence. Otherwise accept alternative hypothesis. If the probability of obtaining the value of T-test of a given or more extreme magnitude is equal or less than 0.05 level of confidence.

Results and discussion

Table 1 measures the closeness of the relationship between the variables in this study-Y the dependant variables and X_1 to X_4 which are the independent variables (i.e. impact of nanotechnology: on Health, on the Environment, on the Society and on Speculative issues respectively). The Table 1 showed that there is a correlation between Y and X_1, of 0.393, Y and X_2 of 0.315, Y and X_3 of 0.141, Y and X_4 of 0.242. This means that there is significant correlation between Y and all the variables predicted in the study, the highest being with X_1 (Health) and least with X3 (the Society). Table 2 shows that R_2 is 0.199, This means that 20% (actual value is 19.9%) of the areas where nanotechnology has impact can be accounted for in this study leaving 80% area not covered. Further research in identifying areas where nanotechnology has impact can improve the value of R_2 Table 2 also showed that F sig change is 0.000. This means that the model is very reliable.

Table 1 Correlations and 1-table test result

Pearson	Y	X_1	X_2	X_3	X_4
Correlation Y	1	0.393	0.314	0.141	0.242
X_1	0.393	1	0.695	0.499	0.214
X_2	0.315	0.698	1	0.621	0.195
X_3	0.141	0.499	0.621	1	0.257
X_4	0.242	0.214	0.195	0.257	1
Sig(1-tailed)Y		0	0	0.021	0
X_1	0		0.01	.0.000	0.001
X_2	0	0		0	0.002
X_3	0.021	0	0		0
X_4	0	0.001	2E-04	0	

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Table 2 Model summary

Model	R	R-square	Adjusted R	Std error of the estimate	Change statistics	
					F change	Sig change
1	0.446	0.199	0.183	1.925	12.733	0

Source: Researcher's computation 2016 (SPSS Version 20).

Table 3 presents the ANOVA report on the general significance of the Model. Since we have F- significance of 0.000 (Less than 0.05 level of confidence) the Model is significant. Thus the combination of the independent variables X_1, X_2, X_3 and X_4 (Health, Environment, Society and Speculative issues respectively) is significantly impacted by the dependent variable Y (Nanotechnology). This thus leads to rejecting Ho and accepting HAi which states that there is significant effect of nanotechnology on the collective areas in Nigeria.

Table 3 F-Test (ANOVA)

Model 1	Sum of squares	Degree of freedom	Mean square	F	Sig
Regression	188.74	4	47.185	12.7	0
Residual	759.66	205	3.706		
Total	948.4	209			

Source: Researcher's computation 2016 (SPSS Version 20).

Table 4 Coefficients and T-Sig Table 4 showed the unstandardized Beta coefficient that presents the contributions of each variable to the model. The T and P values showed the impact of the independent variable on the dependent variables. The decision rule is to consider individual factor with T-Sig value less than 0.05. Thus X_2 (Environment) is the area that nanotechnology has no significant effect on in Nigeria when considered individually and X1 {Health) is the most significant area of its impact. The result from Table 4 also showed that nanotechnology has significant effect on the society (X_3) and speculative issues (X_4) with T-sig value of 0.043 and 0.005 respectively.

Table 4 Coefficients and T-Sig

	Coefficients B Std	Standard coefficients beta	T	Sig
1(Constant)	9.655 1.175	0.33	8.219	0
X_1	0.327 0.087	0.152	3.744	0
X_2	0.161 0.103	-0.166	1.564	0.119
X_3	-0.170 0.083	0.184	-2.04	0.043
X_4	0.132 0.047		2.832	0.005

Source: Researcher's Computation 2016 (SPSS version 20).

Table 5 shows the Standardized Coefficients 8 (Beta) of the independent variables X_1 to X_4 and hence the actual level of impact of Nanotechnology on the areas of study in Nigeria. Using Table 5, the Model one of impact of Nanotechnology on the areas of study in Nigeria can be generated as;

$$Y = 0.330X_1, + 0.152X_2 + 0.166X_3 + 0.184X_4 + 1925 \ldots\ldots \text{Eqn. 3}$$

Y: Impact of Nanotechnology in Nigeria

X_1: Impact on Health

X_2: Impact on the Environment

X_3: Impact on the Society

X_4: Impact on Speculative issues

1.925: Std error of the estimate

Table 5 Standardized coefficients8 (Beta)

Independent variables	Standardized coefficients (Beta)
X_1	0.33
X_2	0.152
X_3	0.166
X_4	0.184

Source: Researchers computation 2016 (SPSS version 20).

Standard error of estimate (SE)

The SE is 1.925. This implies that we can be 95% confident that our observed sample means is 2% (actually 1.92) standard errors from the population means.

Nanotechnology and the nigeria society: thee imperative

When considered individually (Figure 2) and the collective area of study (Figure 3) Nanotechnology has significant impact on the Nigeria Society. Societal impacts are the potential benefits and challenges that the introduction of Nanotechnological devises and materials may hold for society and human interaction.[11] Nigeria to some extend enjoys such advantages of Nanotechnology which includes production using little labor and land, low cost and modest requirements for material and energy. Nigeria is also positively affected by potential opportunities of Nanotechnology to help address critical international developmental priorities which include water purification system, energy system, medicine, pharmaceuticals, food production and nutrition, information and communication technology.[11] Never the less, Nigeria like other developing countries also faces a number of challenges. The majority of Nanotechnology research and development and patents for nanomaterials and products is concentrated in developed countries like United State, Japan, Germany, Canada, and France. In addition, most patents related to Nanotechnology is concentrated among few multi-national cooperation such as IBM, Micron technology, advanced Micron devises, and Intel (Nano factory Information 2914) This has led to fears that developing countries including Nigeria, will have access to the infrastructure, funding and human resources required to support nanotechnology and development and that the inequalities between the developing countries is likely to be exacerbated by nanotechnology. Producers in Nigeria and other developing countries could also be disadvantaged by the replacement of natural products such as Robber, Cutting, coffee and tea by development in Nanotechnology. These natural products are important export crops for developing countries and many farmers livelihood depend on them (PR Web, 2006).

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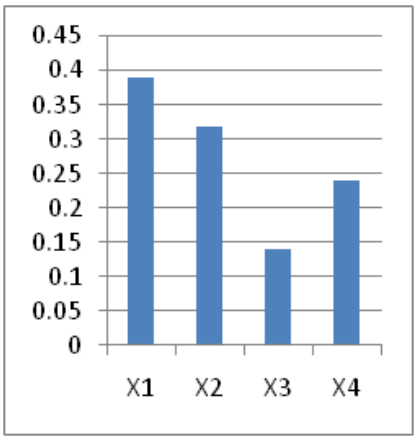

Figure 1 Bar chart showing correlation between independent variable (Y) and dependent variables X_1 to X_4.

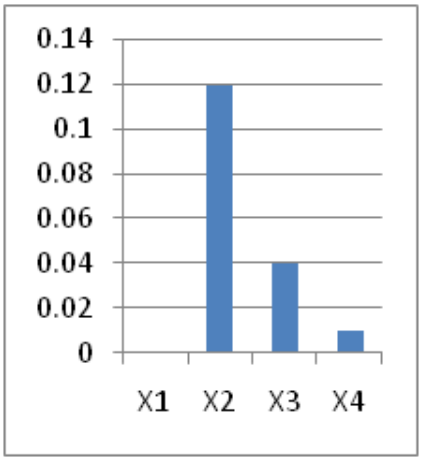

Figure 2 Bar Chart showing T-significance of X_1 to X_4.

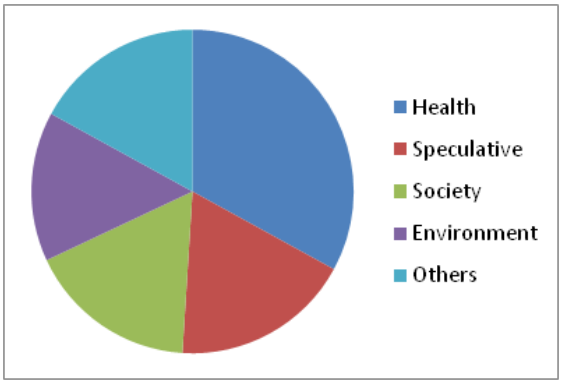

Figure 3 Actual level of impact of Nanotechnology on the areas of study in Nigeria.

Suggestion to enhance the impact of nanotechnology on the Nigeria society

It is proposed that Nanotechnology can only be effective in alleviating poverty and aid development when adopted to social, cultural and local institutional context and designed with active participation of citizen rights. This suggestion seems the imperative in order to enhance the impact of Nanotechnology on the Nigeria Society

Conclusion

The study reveals that nanotechnology has considerable impact on the collective areas of study in Nigeria which include Health, Environment, Society and Speculative issues.

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None.

Conflict of interest

The author declares no conflict of interest.

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