

## INDUSTRIAL MATHEMATICS AS A MEANS OF ENHANCING NATIONAL DEVELOPMENT

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### ABSTRACT

National development involves the interplay of people and their environment to enhance the living standards of members of the society. Indices for measuring national development could be material or social. The important thing is that a country develops when the welfare of its citizens are well taken care of. Industrial mathematics is a specialized field of study with various applications to national development. This study consider the role played by Industrial Mathematics in enhancing national development

**Key words:** Industrial Mathematics, national development, mathematical sciences.

### INTRODUCTION

Not many fields of human endeavor have made so much impact in life as such as mathematics (ESF, 2012). SIAM (2012) is replete with examples of multifaceted applications and interdisciplinary innovations, contributing in no small way in enhancing national development. Historically, earlier applications of Mathematics were obscure, abstract and not very glaring as we have it today. Only a privileged few, especially scientists in areas like Theoretical Physics, Computing and Mathematics itself, could really appreciate the impact Mathematics was making in the real life in the early days of Applicable Mathematics. Many persons initially thought Mathematics was too abstract to find application in other areas of human endeavor (Bohun, 2014).

In the study of Mathematics, there appears to be many caveat emptor, so much so that early areas of application were easily ignored. Mathematics though is an endeavor full of life, and have continued to evolve creating newer fields of study, and branching into several other fields including, Industrial Mathematics, which are now being studied in the Mathematical Sciences.

Industrial Mathematics is one of the specialized fields of study in the Mathematical Sciences that find application in national development. Industrial Mathematics has applications that cut across disciplines such as; Accounting, Management Sciences, Business

Administration, Economics, Mathematical Physics, Computing, Engineering etc. The multi and inter discipline nature of Industrial Mathematics makes it an essential tool for national development.

### What is Industrial Mathematics?

The word “industrial” in Industrial Mathematics is sometimes confusing to the unwary, eliciting the conclusion that it is simply Mathematics applied to the industry, especially the manufacturing sector. This is a misconception which diminishes the various applications of Industrial Mathematics. Even though there are applications of Mathematics like; statistical quality control and linear programming, that have made tremendous impact in the manufacturing industry, Industrial Mathematics applications are not limited to manufacturing. Applications of Industrial Mathematics cut across several aspects of our national life.

According to Bohun (2014) the word “industry” carries a sense of any field with either a commercial or societal benefit. Industrial Mathematics is not restricted to industry in the restricted use of the word “industry”. In the Mathematical Sciences, Industrial Mathematics as a branch of Mathematics, is used as a name to distinguish it from other forms of applicable mathematics and other branches like, Pure Mathematics, Applied Mathematics and Computational Mathematics, that have evolved over the years to be more specific in their areas

of application.

The very common restrictive view of Industrial Mathematics is used by Friedman (1999), who defined Industrial Mathematics as “the creation of mathematical models and the development of algorithms for computer simulations to obtain solutions for problems in industry”. The difficulty of providing a definition for Industrial Mathematics is acknowledged by Bohun (2014), who differentiated Industrial Mathematics from Applied Mathematics, the later being concerned with the use of Mathematics as a tool for analysis.

SIAM (2012) considered the obscurity in the perception of Industrial Mathematics in some quarters “a curious case of double invisibility”, in that the academic and industrial perceptions of Industrial Mathematics are quite different. ESF (2012) was of the view that “industry” refer to “activities outside the realm of education and academic research”. The same conception of “industry” is used in SIAM (2012) and Bohun (2014). But SIAM (2012) gave a more general definition of Industrial Mathematics as the mathematics that involves “all the research that is oriented at solution of problems posed by industrial applications, This definition is adopted for this article.

Industrial Mathematics is armed with mathematical principles, methods and logic to solve real life problems. Because of the quest to solve industrial problems, industrial mathematicians usually acquire knowledge of diverse fields. In most cases, the results from the work of industrial mathematicians are communicated to non-mathematicians. Thus, armed with knowledge of the industrial problem and underlying principles, the industrial mathematician communicates the solutions to the “client” in a manner devoid of elaborate mathematical concepts and notation, without sacrificing quality, thus serving as a bridge of communication between Mathematics and the real world. Industrial Mathematicians make use of all aspects of mathematics including modeling to proffer solutions to real world problems, thus contributing their quota to national development.

### Measuring national development

Industrial Mathematics is a numeric

discipline, and as such, one cannot discuss enhancement of national development by Industrial Mathematics without discussing ways of measuring it. Some authors in the literature connect national development with economic growth (Ranis, 2004; Soubbotina and Shema, 2000; Sahoo et al., 2010).

National development also entails human development in terms of access to basic essentials of life and living. So in measuring national development, even though economic growth is essential, there is the need to measure all-round growth in terms of access to healthcare, education, information, security, good governance etc. Economic growth creates the necessary environment for national development thus making it possible to achieve the goals for national development.

National development is often measured in terms of achievement of national goals, powered by economic development. Normally we talk of sustainable development which suggests that development is a continuous process. Economic measures of national development include national income measures such as; Gross Domestic Product (GDP), Gross National Product (GNP) and Gross National Income (GNI). These economic measures are often expressed as per capita indexes, which is the case when economic measures are divided by the number of persons in the population.

The incidence of poverty in a country can also be a measure of the development of such a country. The incidence of poverty in Nigeria is estimated by NBS (2012) at 69.0%. This means that with an estimated population of about 163 million persons, about 112.47 million persons live in poverty. Some useful insight as to the estimation of poverty indexes is provided in Tsetimi (2015).

Most economic measures generally base development on income, but the United Nations (UN) uses a broader measure of development called the Human Development Index (HDI). HDI consist of a number between 0 and 1, 0 being the lowest level of human development, while 1 is the highest level. The HDI is made up of three main *components* namely; *adult literacy and average years of schooling, life expectancy, and per capita income*. Indexes released by the United Nations Development Programme (UNDP) in 2014 shows that Nigeria is ranked

152 out of a total of 187 countries (UNDP, 2014).

Nigeria is classified in that report in the low human development group with HDI value of 0.504 a marginal increase of 0.004 compared with value of 0.500 for 2013, making the country to climb just one place up

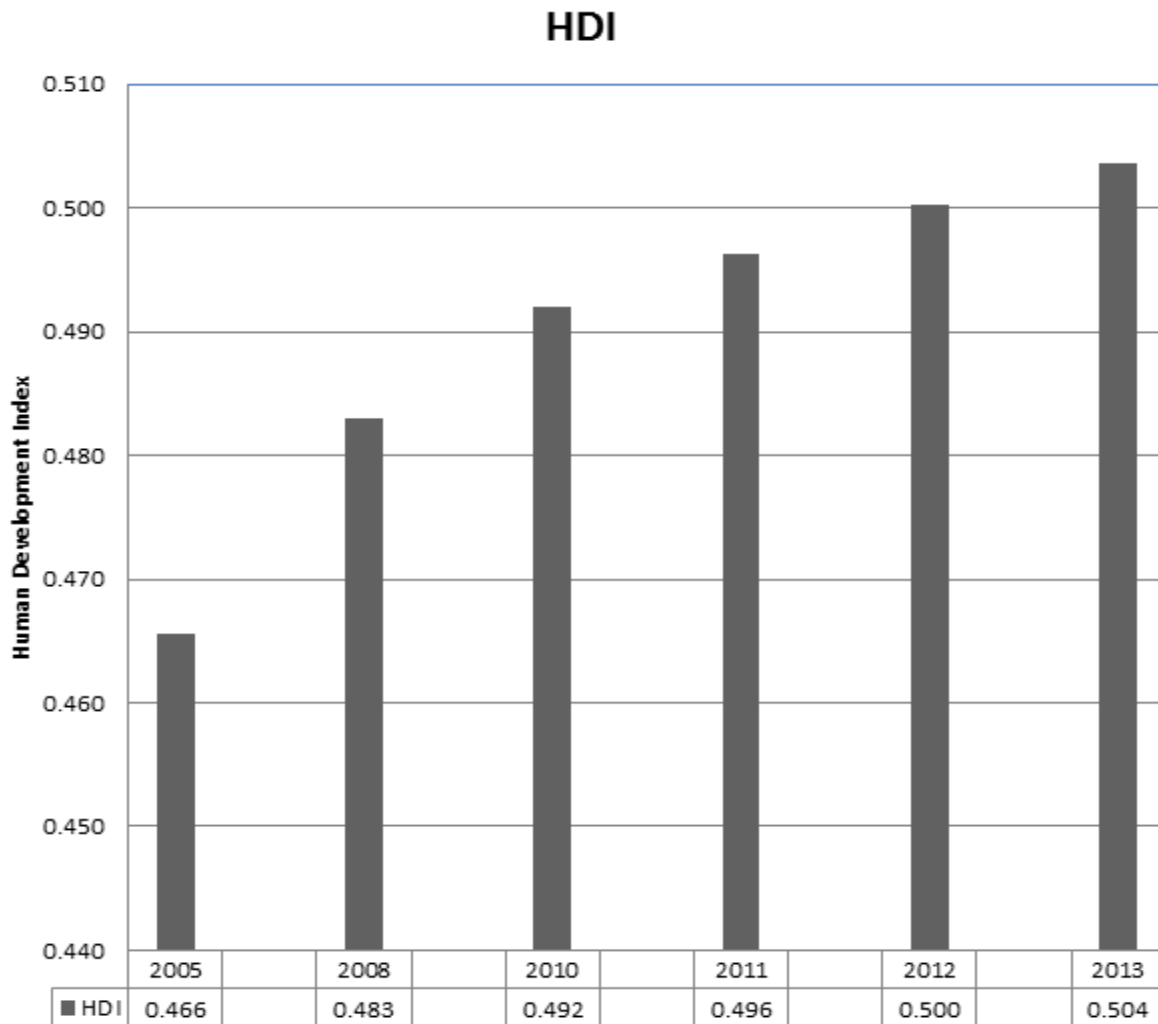
in the ranking against the 2013 rank of 153 out of 187 countries. Table 1 is culled from UNDP (2014), which shows the HDI and its components for Nigeria in 2014.

Figure 1 shows the trend in the HDI for 2005 to 2013 (UNDP, 2014). There is an observed pattern of slow but steady increase in

**Table 1.** Nigeria’s human development index and its components.

HDI and components	Value
HDI Rank	152
HDI Value	0.504
Life Expectancy at birth (in years) 2013 data	52.5
Mean years of Schooling 2012 data	5.2
Expected years of Schooling 2012 data	9.0
Gross National Income (GNI) per capita (2011 PPP in \$) 2013 data	5.353
HDI Value for 2012	0.500
Change in rank 2012-2013	1

**Source:** United Nations Human Development Programme (UNDP), 2014.



**Figure 1.** Trends in HDI for Nigeria (2005-2013).

HDI for Nigeria. There is the need to improve on the rate of growth and sustain steady growth for some years which may lead to improvement in the overall wellbeing of citizens provided the gains are not cancelled by vulnerability to poverty, of which a major factor is insecurity (Chauduri, 2003).

For sustainable national development, Nigeria need to harness all resources it can garner. The available resources include human and material resources. Included in the human resources available for development are industrial mathematicians who can play a major role in sustainable development for the nation Nigeria. The Industrial Mathematics curriculum is discussed in the next section, highlighting areas of the curriculum that are vital to sustainable development.

### **Industrial Mathematics curriculum**

Industrial Mathematics is one of the courses taught by approved/accredited universities in Nigeria as can be seen in NUC (2015). A look at the programmes of some universities accredited to offer Industrial Mathematics shows a rich curriculum comprising of “traditional” pure mathematics courses and applied mathematics courses. Industrial Mathematics programmes in Nigerian universities also include courses in Computer Science, Accounting and Finance, Business Management and Economics. Some programmes also include courses taught in engineering disciplines like production engineering.

No nation can develop without adequate management and accountability for its finances. Industrial Mathematics students are equipped to contribute to management of the nation’s resources by taking courses in accounting and finance. Economic indexes and analysis assist the government in planning and appropriation of funds. The accuracy of economic indexes depends largely on the numeric skills and understanding of economic principles by the analyst. With the knowledge in economics imparted in the Industrial Mathematics graduates they can work as analysts and consultants producing and analyzing the necessary indexes to assist ministries departments and agencies (MDAs) in coping with ever changing economic

climate, and thus, contributing to the national development of our nation.

The computing skills acquired by industrial mathematicians from the curriculum are a great asset in this era of information and communications technology (ICT). It can be said that ICT is the major driving force for national development in today’s world. ICT is a major tool in business, education, banking and health services which are crucial sectors in national development. Industrial mathematicians receive training to enable them work as computer programmers, system analysts and database administrators (see SIAM, 2012), who play major roles in the industry for the development of the Nigerian economy.

Business management courses in the Industrial Mathematics curriculum are very essential to national development especially for the acquisition of entrepreneurial skills to prepare graduates to face harsh economic realities. Where entrepreneurial skills graduates can elect to establish and manage their own businesses thus, reducing the rate of unemployment, and contributing to national development.

### **Importance of Industrial Mathematics to national development**

The study discussion in this section consists of the importance of Industrial Mathematics, and how it can contribute to national development. National development is a function of the general wellbeing of the society. In line with the components of HDI, the study considers core areas of national development where Industrial Mathematics has crucial role to play. The study considers the importance of Industrial Mathematics in the areas of life expectancy and health, education and years of schooling, and per capita income.

### **Life expectancy and health**

Accurate statistics on demographics are essential for planning that can enhance healthy living, and a healthy population is more like to have higher life expectancy figures. Statistics collected and analyzed by industrial mathematicians can enhance living standards health wise. Mathematical models, analysis and forecasts also assist the health sector in disease control. According to Hethcote (2000), a good example of a mathematical model that has proved

very useful in healthcare is the classical Kermak and Makendrick SIR model. SIR is an acronym for “susceptible, infective and recovered”, representing the three segment of a population in case of an epidemic. The SIR model is given by the differential equations:

$$\frac{dS}{dt} = -\beta SI, \frac{dI}{dt} = \beta SI - \gamma I, \text{ and } \frac{dR}{dt} = \gamma I$$

(1) (Hethcote, 2000).

This model divides the population into three groups; susceptible(S), infective(I) and recovered(R), where  $S+I+R = I$ , with  $\beta > 0$  and  $\gamma > 0$  as the infection and removal rates respectively. This model can be applied to help healthcare providers to effectively deal with epidemics thus, improving average life expectancy of the nation and enhancing national development.

Industrial Mathematics contributes its quota to national development in the area of life expectancy and health by supporting various researches and innovations geared towards improvement in healthcare delivery. Modeling, simulation, algorithm and software are important ancillary areas of healthcare that need inputs from industrial mathematicians.

SIAM (2012) highlights innovations in systems biology, molecular dynamics and whole-patients models as areas where industrial mathematics is playing a major role. Simulation is another area where Industrial Mathematics can assist in healthcare. With simulation, healthcare models can be tested by evaluating variables and observing results before wholesale application of such models.

### **Educations and years of schooling**

The mean years of schooling and expected years of schooling in Nigeria are respectively 5.2 and 9.0 years (UNDP, 2014). In the 6-3-3-4 system of education being operated in Nigeria (Wikipedia, 2015), it takes about 16 years of schooling to train an industrial mathematician. Prospective university students usually run away from the mathematical sciences possibly because of the phobia they have developed for mathematics over the years. In many cases, students are admitted to read Industrial Mathematics with very high rate of attrition. With some encouragement though, prospective university

students would show more interest in Industrial Mathematics. With more interest in Industrial Mathematics and concomitant increase in enrollment figures, the mean and expected years of schooling are likely to increase.

Industrial Mathematicians contribute to education in Nigeria, and thus also to national development. Industrial Mathematicians can be involved in research, in the areas of Operations Research, modeling of complex systems and cloud computing. Other areas in the industry where Industrial Mathematicians can contribute include multidiscipline research design and analysis, and measurement and evaluation. Even though they not trained teachers, graduates of Industrial Mathematics can augment in the much needed manpower in the teaching of mathematics in the secondary schools.

### **Per capita income**

The per capita income of a country is the total income divided by the number of persons in the population that is, the amount of income per person (Investopedia, 2015). Industrial mathematicians are contributing, and has immense potentials to continue to contribute in no small way to improving the per capita income of Nigeria as a developing nation. Case studies in SIAM (2012) highlighted key areas of economy where industrial mathematicians are making impact. These areas include business analytics, mathematical finance, oil discovery and extraction and manufacturing.

Industrial mathematicians are also making major impact in communication and transportation, and in the modeling of complex systems. By providing much needed statistics, analysis, models and algorithms, Industrial Mathematics can also contribute to the agricultural sector as a viable alternative to the mainstay of the Nigerian Economy, especially with the current dwindling fortunes from oil revenue.

Business analytics involves the activities of mathematicians in the industry using a combination of methods and techniques in Operations Research and Management Science. With business analytics, Industrial Mathematics contributes to the per capita income of the nation by expanding the frontiers of business through predictive analysis, image analysis and data mining, and operations research.

Industrial Mathematics plays a major role in enhancing our national development through mathematical finance. Mathematical finance is found very important in the economy especially in areas like stock markets and real estate management, by providing quantitative techniques to solve real-life problems and coping with the prevailing market conditions. According to SIAM (2012), Industrial Mathematics can provide basin models, algorithms and simulation techniques to aid oil exploration and extraction in the oil industry.

Manufacturing is the mainstay of most developed countries. Industrial Mathematics can contribute to manufacturing through design prototyping, multidiscipline design, optimization and computer –aided design (CAD). Industrial Mathematics also plays important roles in robotics and supply chain management which are crucial to the manufacturing sector. In communication and transportation, Industrial Mathematics contributes immensely through provision of algorithms, software and techniques especially in the areas of logistics and cloud computing. Industrial Mathematics also plays important roles in modeling complex systems, which are often broken down into smaller subsystems thereby, enabling faster and more viable solutions.

### Conclusion

Mathematics has always impacted life and living, and would continue to make more impact in our national development in the form of Industrial Mathematics. A developing nation like Nigeria needs inputs from all available resources to improve its HDI and sustain developmental strides to make life and living more favorable for its citizens. This study has elected to discuss Industrial Mathematics as a means of enhancing national development. Industrial Mathematics also has a crucial role play in bridging some of the misconceptions between the activities of mathematicians in the academia and those in the industry, this role would be x-rayed in a further work. With more understanding of the activities of industrial mathematicians, more favorable environment can be created for Industrial Mathematics to contribute its quota to national development.

### Conflict of interests

The author has not declared any conflict of interests.

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