

## Chemistry Entrepreneurship for Small and Medium Enterprises Development: A Panacea for Job and Wealth Creation

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### Abstract

Chemistry is everything and everywhere, as a result chemistry offers wide varieties of business opportunities for small and medium enterprises development than any other discipline. Professional chemists including students of chemistry, with little training on entrepreneurial skills could begin to commercialize their innovations to reap enormous financial benefits; become job creators and contribute positively to the national economic development most especially through the small and medium enterprises. Chemistry entrepreneurship, a subset of academic entrepreneurship; it involves the process of converting innovations in Chemistry into marketable products for commercial gain. It enables Chemists to take their work beyond publications in academic journals by patenting and commercializing them for economic gains. This paper calls for curriculum re-engineering to fully integrate entrepreneurship into Chemistry curriculum at degree level as well as to encourage researchers to make commercialization a part of their research agenda from the stage of project conceptualization.

Keywords: Chemistry, Chemistry entrepreneurship, Business opportunities, innovations, commercialization, small and medium enterprises.

### 1. INTRODUCTION

What is not Chemistry? Can there be a Day without Chemistry? Can Chemist be a billionaire? It is sure that any person with basic knowledge of chemistry or science is capable of answering these questions most especially the first two questions based on research experiences in laboratories or interaction with the chemistry or science world in general. The third question is probably the thrust of this paper. After provision of satisfactory responses to the first two questions, then, the question is, how can chemists convert the outcomes of their researches in the laboratories into investment opportunities for financial benefits to create more jobs for the chemists or scientists in general in a declining job market in Nigeria as well as ensuring national prosperity through wealth creation?

Chemistry entrepreneurship is a subset of academic entrepreneurship which is in turn a subset of what is referred to as knowledge economy. Academic entrepreneurship has the sole objective of commercialization of innovations developed by academic scientists in universities and research institutes via patenting, licensing, start-up creation, and academic/university-industry partnerships (Phan and Siengel, 2006; Siengel, Veugelers and Wright, 2007; Rothaermel, Agung and Jiang, 2007). The concept of academic entrepreneurship became prominent in the US especially in the days of decreasing funding of universities during the Reagan Administration (Grimaldi, Kenney, Siegel and Wright, 2011).

Also, government of the US began to think of appropriate policy direction regarding academic entrepreneurship in the late 1970s when the country faced apparent deterioration of national comparative advantage in the manufacturing industry due to increasing competition from the Japanese firms (Coriat and Orsi, 2002; Florida and Kenny, 1990). Policy makers were convinced based on the huge success of the Silicon Valley project that US could improve on its competitive advantage by introduction of newest science-based technologies already developed and that would be developed in the universities or research institutes while the old technologies would be abandoned (Branscomb and Brooks, 1993). According to David (1994), this was the emergence of specific expectations regarding the direct contributions of academic institutions to economic growth with particular attention to local industrial environment. As a result, US universities gradually became part of a societal response to global economic challenges (Grimaldi and von Tunzelmann, 2002).

One major policy that has influenced academic entrepreneurship tremendously in the US is the Bayh-Dole Act of 1980. The Bayh-Dole Act provides incentives for firms and universities to commercialize university-based technologies (Grimaldi and von Tunzelmann, 2002). The Act instituted a uniform patent policy across federal agencies and removed restrictions on patenting while allowing universities to own the patents arising from federal research grants but stipulated that researchers working on a federal grant are required to disclose their inventions to the technology licensing office (Berman, 2008; Mowery, Nelson, Sampat and Ziedonis, 2004). For example, Yale University sued John Fenn, the winner of the 2002 Nobel prize in Chemistry for compensation for secretly patenting a process he developed while working as a researcher at Yale University. The judge in the case agreed with Yale University and awarded \$1 million to the university (Grimaldi and von Tunzelmann, 2002; Borman, 2005). Despite the fact that the Act encourages commercialization and applied research in the universities, evidences are however, abundant in literature that the rise of commercialization

associated with the Bayh-Dole Act has not resulted in less basic research in the universities (Thursby, Fueller and Thursby, 2009).

The objective of this paper is therefore, is to examine chemistry entrepreneurship in small and medium enterprises development within the context of academic entrepreneurship and knowledge economy in general with a view to encouraging researchers in the field of chemistry to commercialize their inventions for financial gains and to motivate students to become chemistry entrepreneurs thereby making them job providers rather than job seekers in the overblown labour market in Nigeria to enhance national economic prosperity.

## 2. WHAT IS CHEMISTRY?

For conceptual purpose, let us look at an operational definition of Chemistry and how chemistry is used in our daily life which will later form the basis for our call for chemistry entrepreneurship for small and medium entrepreneurship development.

Bagley (2014) defined Chemistry as the study of matter, its properties, how and why substances combine or separate to form other substances, and how substances interact with energy. Chemistry can also be defined as a branch of physical science that studies matter in terms of: Composition, Structure, Properties and Transformation/Change. Matter is composed of atoms and molecules; chemistry studies the interactions and transformations of matter. Remember, matter is neither created nor destroyed; what we have is transformation of matter. Chemistry is central to natural sciences as such sometimes referred to as the Central Science.

Understanding basic chemistry concepts is important for almost every profession. There is chemistry in any discipline you can imagine: Biology (Biochemistry); Pharmacy (Pharmaceutical Chemistry); Food (Food Chemistry); Agriculture (Agricultural Chemistry); Plant Science (Phytochemistry); Geology (Geochemistry); Radiology (Radiochemistry); Zoology (Zoochemistry); Astrology (Astrochemistry); etc. to this extent, it is good to know that chemistry is everything and everywhere.

It is interesting to note that Chemistry can be found in the kitchen, restaurant/fast food; laundry, beauty salon, garden, swimming pool, hospital, hotel and beer parlor, toilet and bathroom, air, bakery, water corporation, power station, military formations/barracks, photo laboratory, paint and textile stores, business centres, house roof, inside ship car, train and aircraft, wastes dump sites, fire station, barbing salon, artist shop, plumbers shop, carpentry workshop, coal pit, quarries, and other areas of human endeavor.

It is important to note also that everything we hear, see, smell, taste, and touch involve chemistry and hearing, seeing, tasting, and touching all involve intricate series of chemical reactions and interactions in our body. With such an enormous range of topics, it is essential to have basic knowledge of chemistry to understand the world around us and to take pretty advantage of such knowledge to convert them into entrepreneurial activities.

Today, advances in chemistry in the areas of chemical biology, electrochemistry, computational chemistry, synthesis and analytical science, bio and solar fuels, supramolecular chemistry and nanoscience, materials and prosthetics, ageing, nuclear energy, catalysis, supercapacitors, material sciences etc have made life more comfortable.

## 3. WHAT IS ENTREPRENEURSHIP?

Today, entrepreneurship has become an unavoidable issue especially by policy makers who have seen entrepreneurship as means to addressing increasing rate of unemployment, youth unemployment in particular is worrisome in Nigeria; and so, the concept is gaining so much ground as a powerful agent for job creation especially through the small and medium enterprises. The concept of entrepreneurship is fast becoming a great phenomenon in the world and it is being embraced by developed and developing nations alike.

Since entrepreneurship is usually associated with micro, small and medium enterprises, government of nations have used it to promote economic development, MSMEs (micro, small and medium enterprises) being generally accepted as engine of growth most especially in developing economies.

Entrepreneurship has been defined in many ways by different authors; sometimes the background of the author affects his/her definition. Cantillon (1755) first defined and wrote on the subjects of entrepreneur and entrepreneurship after which several other authors have written on this subject. Some of these authors include: Joseph Schumpeter (1934) who expressed that the single function which constitutes entrepreneurship is innovation. Ronstadt (1984) gave an all-embracing definition of entrepreneurship "as the dynamic process of creating incremental wealth" while Hisrich (1986) defined entrepreneurship as the process of creating something new with value, by devoting the necessary time and effort, assuming the accompanying financial, psychic, and social risks and receiving the resulting rewards of monetary and personal satisfaction and independence.

Lumpkin and Dess (1996) are of the opinion that entrepreneurship encompasses every step taken by an entrepreneur in entry to a new business and its concomitant problems of new start-ups. According to Covin and Slevin (1989), entrepreneurial style of management is that in which top managers are inclined to take business risks, are proactive and favor change and innovativeness. Schoof (2006) observed that entrepreneurship is an

innovative approach to integrating youths in some countries into the labour markets. The focus is currently zeroed on the contributions of entrepreneurs in the economic growth of several nations, including the advanced nations.

Put simply, entrepreneurship is the process of becoming an entrepreneur. It is a term derived from the word "entrepreneur", it is simply the act of being an entrepreneur. Entrepreneurship involves a process of creating something new with value through innovation with associated financial reward.

It is pertinent to highlight some of the very prominent features of entrepreneurship as presented by Elemo, Oyeku, Adeyemo, Tamasi and Adesegha (2013):

- Entrepreneurship traits occur naturally or can be developed.
- It is an innovative approach to running a business (small or large).
- It is important for both newly conceived and old businesses.
- It entails dynamism and growth.
- It is driven by opportunity (rather than resources) which is need or market-driven.
- It involves taking risks which are calculated and bearable and would involve evaluation of each situation, risk factors envisaged, strategies to manage or minimize them, etc.

Ketchen (2003) and Venkataraman (1997) opined that entrepreneurship serves as a linchpin between invention, innovation, and introduction of new products and services in the market place and also enables the entrepreneurs to act as engine of growth in the economy. Entrepreneurship is therefore, linked to entrepreneurial opportunities, the compelling forces enabling entrepreneurs to introduce or develop new products or services (Inyang and Enuoh, 2009).

Stevenson and Mossi (1986) have argued that a too narrow definition of entrepreneurship may exclude the concept of corporate entrepreneurship whereas a too broad definition could also make it equivalent to good management thus dissolving it as a specialized field of study. With corporate entrepreneurship in mind, Stevenson, Roberts and Grousbeck (1989) defined entrepreneurship as a process by which individuals – either on their own or inside organizations – pursue opportunities without regard to the resources they currently control. This paper therefore, adopts the definition of entrepreneurship as defined by Stevenson, et al (1989).

### 3.1 Who is an Entrepreneur?

Just like entrepreneurship, scholars define entrepreneurs from different perspectives without agreeing on a particular definition. The term "entrepreneur" is French in origin. To Cantillon (1755), an entrepreneur is one who bears uncertainty, buys labor and material, and sells products at certain prices. Say (1942), considers the entrepreneur as the pivot of the economy and a catalyst for economic change and development whereas Schumpeter (1934) sees the entrepreneur as an innovator who does new things in a new way; supplies new products; makes new techniques of production, discovers new markets, and develops new sources of raw materials. Meredith, Nelson and Neck (1991), posits that entrepreneurs are people who has the ability to see and evaluate business opportunities; to gather the necessary resources and to take advantage of them; and to initiate appropriate action to ensure success.

An entrepreneur can also be defined as an individual that generates business idea, convert the idea into product or service, and start a business enterprise based on the business idea with the aim of making profits and assuming risk involved in the management of the enterprise. To this extent, Mr. Aliko Dangote, Mrs. Folorunsho Alakija, Bill Gates, Job Steve (Late), Mike Adenuga, Wale Tinubu are typical examples of entrepreneurs.

According to Kanter (1983), an employee working in an existing organization may also be engaged in entrepreneurial activities through innovation and product development. Such employee is referred to as "intrapreneur". Desire for self independence or autonomy, frustration, dissatisfaction can make such employee to leave the organization he works for and establish a new company to put his ideas into practice; in this case he becomes an entrepreneur (Inyang and Enuoh, 2009).

### 3.2 Characteristics or Attributes of an Entrepreneur

An entrepreneur requires what is known as entrepreneurial skills to function effectively. These are the needed skills to bring idea from concept to a value creating and profitable firm. Entrepreneurial skill has both technical and management components. Most businesses failed in Nigeria due to business owners possessing high technical component but lacking management component of entrepreneurial skill to run businesses successfully (Elemo, 2013).

It has been generally observed that entrepreneurs possess some exceptional characteristics which differentiate them from the mere business owners. These characteristics include perseverance, hardworking, autonomy, energetic, persuasiveness, flexibility, and so on (Elemo, 2013). Yonekura (1984) in the discussion paper on "Entrepreneurship and Innovative Behaviour of Kawasaki Steel" suggested the following traits or characteristics of an entrepreneur: assertiveness, insistence, forward-looking, critical thinking, creativity, innovation, continuity, preparedness, responsibility, open-mindedness, etc. Also, Burch (1986) mentioned nine

salient traits, which are responsible for a high propensity to behave entrepreneurially to include: desire to achieve, hard work, nurturing quality, able to accept responsibility, reward oriented, optimistic, excellence-oriented, an organizer, and money-oriented.

These attributes are grouped into three and presented below.

#### a. Entrepreneurial Orientation

According to Lumpkin & Dess (1996) entrepreneurial orientation referred to processes, practices, and decision making activities that led to new entry. However, Lumpkin & Dess (1996) conceptualized entrepreneurial orientation to consist of five dimensions of innovation, proactiveness, risk-taking, autonomy and competitive aggressiveness whereas Venkatraman (1989) identified 6 dimensions of strategic (entrepreneurial) orientation: aggressiveness, analysis, defensiveness, futurity, proactiveness, and riskiness.

This paper adopted the Miller's (1983) and Covin and Slevin (1986) three dimensions of entrepreneurial orientation i.e. risk taking, innovation, and proactiveness with the assumption that autonomy and competitive aggressiveness are elements of proactiveness and therefore, subsumed in proactiveness dimension.

#### b. Entrepreneurial Competency

Competency has been defined to encompass clusters of skills, knowledge, abilities, and behaviour required for people to succeed (Davis, Naughton, and Rothwell, 2004). Sarwoko, Surachman, Armanu, Hadiwidjojo (2013) defined entrepreneurial competency as the individual characteristics including attitude and behavior, which allow the entrepreneur to achieve business success.

According to Man, Lau and Chan (2002), entrepreneurial competencies are a set of higher-level characteristics involving personality traits, skills and knowledge. They can be viewed as the total ability of the entrepreneur to perform his role successfully. Moreover, Kiggundy (2002) noted that entrepreneurial competency is the sum total of the entrepreneur's requisite attributes for successful and sustainable entrepreneurship, including attitudes, values, beliefs, knowledge, skills, abilities, personality, wisdom, expertise (social, technical, managerial), mindset and behavioral tendencies.

According to Bird (1995), competencies are seen as behavioral and observable but only partly intrapsychic characteristics of an entrepreneur. Consequently, competencies are changeable and learnable, allowing intervention in terms of the selection, training and development of entrepreneurship. Man et al. (2002), identified six major areas of entrepreneurial competencies in relation to an SME context, including opportunity, relationship, conceptual, organizing, strategic, and commitment competencies. These competencies are supposed to play different roles in affecting an SME's performance with their direct and indirect effects. Inyang and Enuoh (2009) analyzed nine areas of entrepreneurial competencies which they considered as the missing link to successful entrepreneurship in Nigeria. These are: time management, communication, human resources management, marketing management, business ethics, social responsibility, leadership, decision making and financial management.

#### c. Entrepreneurial Self Efficacy

Self-efficacy has been defined as entrepreneur's task-specific self-confidence (Boyd and Vozikis, 1994; Baron and Markman, 1999; Baum and Locke, 2004) while others in contrast have defined self-efficacy as the ability to master the necessary cognitive, memory processing, and behavioural facilities to deal effectively with the environment (Chen, Greene and Crick, 1998; Segal, Borgia and Schoenfeld, 2002).

Self-efficacy, according to Bandura (1982) is the conviction that one can successfully execute the desired behavior (e.g., successfully launch a business) required to produce an outcome. Self-efficacy also refers to people's judgments regarding their ability to perform a given activity (Bandura, 1977; Bandura, 1982; Bandura, 1986) and is proposed to influence individual choices, goals, emotional reactions, effort, ability to cope, and persistence (Gist, Stevens & Bavetta, 1991).

In the case of entrepreneurship, entrepreneurial self-efficacy may be comprised of deliberation of those tasks that relate to the initiation and development of new ventures. Campo (2011) defined entrepreneurial self-efficacy as the degree to which one believes that he or she is able to successfully start a new business venture. Segal, Borgia and Schoenfeld (2005) asserted that individual with high entrepreneurial self-efficacy has the tendency to become an entrepreneur later in life. Self-efficacy involves the belief that we can effectively organize and execute certain actions (Bandura, 1997; Chen, Greene, & Crick, 1998; Gist & Mitchell, 1992).

It is appropriate to consider the relationship between overconfidence, optimism and entrepreneurial self efficacy. Forbes (2005) suggested that overconfidence measures the accuracy of an individual's ability whereas entrepreneurial self-efficacy measures the individual's perception of their abilities. Forbes (2005) further suggests that an individual's entrepreneurial self-efficacy may vary, with some individuals having over-inflated opinions about their abilities therefore, in such situation, an individual is more likely to demonstrate overconfidence in their abilities. Similarly, experienced entrepreneurs may have a high entrepreneurial self-efficacy based on previous business success that subsequently leads to greater overconfidence (Douglas & Fitzsimmons, 2005). There are three main categories of overconfidence: 1) overconfidence in knowledge, 2) overconfidence in prediction, and 3) overconfidence in abilities (Hayward, Shepherd and Griffl, 2006).

Parker (2006) argues that certain findings in the psychology literature suggest that entrepreneurs are particularly optimistic. Optimism has also been regarded as a functional characteristic of entrepreneurs, since highly confident individuals are better positioned to start subsequent businesses as they are more likely to cope with high failure rates and to endure the usually tough process leading to new venture success (Hayward, Forster, Sarasvathy and Fredrickson, 2010).

Entrepreneurial experience has been found to inform entrepreneurial optimism of high chances of entrepreneurial success (Lejarraga and Pindard-Lejarraga, 2013). In an empirical study, Ucbasaran, D., Westhead, P., Wright, M., Flores, M. (2010) found that the nature of entrepreneurial experience has diverging effects on optimism, such that experiences with business failure were associated with lower optimism as opposed to experiences with business success and this relation was moderated by whether entrepreneurs were sequential or portfolio entrepreneurs.

In Oyeku, Oduyoye, Kabouh, Elemo, Karimu, and Akindoju (2014), entrepreneurial self efficacy refers to subjective self belief of an entrepreneur expressed in terms of optimism to start an enterprise and overconfidence to run it successfully. The authors propose a modification to the New General Self Efficacy (NGSE) scale to measure entrepreneurial success.

### 3.3. Entrepreneurship Development in Nigeria

Entrepreneurship development is still at its lowest ebb in Nigeria despite concerted efforts of the Federal government and various entrepreneurship development institutions. One of such laudable efforts is the institutionalization of entrepreneurship development programme in the curriculum of tertiary institutions in Nigeria by the National University Commission, NUC (Unachukwu, 2009).

Ajagu (2005) argued that entrepreneurship is near absent in Nigeria and that the dearth of information in this area has resulted in only few ventured into it without the prerequisite information to succeed while others have to abandon their dreams.

Even though, large awareness has been created for entrepreneurship development, most especially as a way out of the current high rate of unemployment, Nigeria, in 2014 rated 74<sup>th</sup> in Global Entrepreneurship Development Index with countries like Malaysia (45<sup>th</sup>), Saudi Arabia (46<sup>th</sup>), South Africa (51<sup>st</sup>), Tunisia (61<sup>st</sup>), Cyprus (52<sup>nd</sup>), Lebanon (55<sup>th</sup>) and Namibia (52<sup>nd</sup>) coming ahead of Nigeria.

However, in the total entrepreneurial activities per country for 2012, Nigeria (35%) came ahead of countries like Denmark (5%), Egypt (8%), Malaysia (7%), France (5%), Germany (5%) and Israel (7%).

The high entrepreneurial activities could not however, translate to better GEDI (Global Entrepreneurship Development Index) rating because our entrepreneurial activities generally lack process innovation, product innovation etc. The way Nigerian entrepreneur cook and sell corn; fry and sell "akara" remain the same for ages without any innovation.

Global Entrepreneurship Development Index (GEDI) is evaluated on 3EAs of: Entrepreneurial Abilities, Entrepreneurial Attitudes and Entrepreneurial Aspiration (GEDI, 2014). The 3EAs are based on 15 main pillars of which opportunity perception, opportunity start up, start up skill, technology absorption, human capital, product innovation and process innovation are chief determinants of Global Entrepreneurship Development Index. These pillars have direct impacts on the level of entrepreneurship development of a country. This explains why countries with high level of technological development have high GEDI ratings.

### 4. CHEMISTRY ENTREPRENEURSHIP – WHAT IS IT?

It is accepted that Chemistry is everything and Chemistry is everywhere but why are Chemists not getting employed? Ordinarily one will think that Chemists should be hot cakes in the labor market since they have roles to perform in virtually all areas of human endeavors.

From Chemistry entrepreneurship point of view, Chemists with great ideas, with a little training on entrepreneurship, are supposed to be job creators rather than job seekers. It is however, doubtful if institutions responsible for the training of Chemists in Nigeria have integrated entrepreneurship as an integral aspect of their Chemistry curriculum rather than taking entrepreneurship as a general course even though, a compulsory course. The result of this is that we see students graduating with higher degrees in Chemistry even with commercializable research projects but lack entrepreneurial skills or know-how to convert them into commercial or marketable products with a view to reaping individual financial benefits as well as providing opportunities for national economic development.

Chemistry entrepreneurship therefore, involves the process of converting innovations on Chemistry into marketable products for commercial gain. With increasing awareness in Chemistry entrepreneurship, there is a paradigm shift from conducting basic research whose results end up only in academic journals but today, Chemists and scientists in general are thinking of taking their work beyond publications by patenting and commercializing them for economic gains.

Therefore, achieving transformation of novel science into successful business ventures is key to the

long term profitability of the world's chemical and related industries but this goal requires scientists who possess a critical combination of both technical and entrepreneurial skills. This is because activities of commercialization are quite different almost in direct opposite to activities in the laboratories. Increasingly, such individuals are playing a pivotal role in today's knowledge-driven economy by enhancing existing businesses and by setting up new ventures themselves.

Scott P. Lockledge, holds a PhD in Inorganic Chemistry, and a Chief Executive Officer and Co-founder of Tiptek, a company that manufactures of ultrahard and ultrasharp probes for atomic force microscopy applications says that "Founding a company gives you the opportunity to create an enterprise, be it large or small, in which you know you are personally making a difference" and that "working in a large company can feel like being a small gear in a large machine" Lockledge explained further that he was motivated to become an entrepreneur by the desire to control his own destiny. He noted that "when you work for someone else, your boss's priorities dictate your work-life and lifestyle," whereas as an entrepreneur, you can decide when and where you work. Lockledge also added that "Inventing and innovating is fun, and the opportunity to do so in a large company setting is increasingly rare.

The Universities, in Brazil and all over the world are currently going through a "second revolution" in which the socio-economical development is incorporated as part of their mission and science and knowledge play a key role for the development of the society.

In promoting chemistry entrepreneurship, the School of Chemistry in conjunction with the Nottingham University Business School, USA is running a programme on M.Sc. Chemistry and Entrepreneurship. The course aims to provide students with an appreciation of the interrelationships between fundamental research and its commercial exploitation while the students will also be able to take advantage of the course's flexible structure to develop an understanding of specific areas of modern Chemistry and to become fluent in the financial, marketing and managerial aspects of modern business. Another objective of the course is to make students to acquire the technological and business background to enable them to make a significant contribution to today's chemistry-based, technology-driven economy.

Also, the Department of Chemistry at Case Western Reserve University, Cleveland, Ohio, USA runs the Chemistry Entrepreneurship Program (CEP), a two-year professional M.Sc. in Chemistry Entrepreneurship where the students study state-of-the-art Chemistry, practical business, and technology innovation while working on a real-world entrepreneurial project with an existing company or the student's own startup. The CEP also helps connect students with mentors, advisors, partners, funding sources and job opportunities.

#### 4.1 Chemistry World Entrepreneur Award

In recognition of chemistry entrepreneurship as a discipline, and profession, as well as to promote and encourage Chemistry entrepreneurship, the Royal Society of Chemistry, has instituted an award, i.e. Chemistry World Entrepreneur of the Year. This is an annual award valued a cash prize of £4,000 given to individuals who demonstrated creativity and vision, driving chemistry innovation to commercial success for their businesses.

Professor Paul Workman of the Institute of Cancer Research received the 2012 award based on his work as a scientific pioneer and serial entrepreneur whose numerous commercialized discoveries and academic research led to his founding two successful chemical companies: Piramed Pharma and Chroma Therapeutics

The award for 2013 was received by Professor Chad Mirkin of the Northwestern University, USA based on his scientific and academic achievements involving spherical nucleic acid (SNAT) nanoparticle conjugates while Professor Tom Brown of University of Oxford received the 2014 award for pioneering research on nucleic acids which was successfully commercialized. The question is can a Nigerian Chemist, a researcher based in Nigeria receive the next Chemistry Entrepreneur Award? This is pretty possible one day but we need to kick start the process now – Chemistry entrepreneurship!

#### 4.2 Why Chemistry Entrepreneurship?

The following are some of the general reasons for advocating Chemistry entrepreneurship or entrepreneurship in general.

##### a. The need to tackle unemployment.

Enrolment in tertiary institutions in Nigeria is increasing day-in-day out. The reality is that government and the organized private sectors, do not have enough capacity to absorb the graduates of these institutions. The National Bureau of Statistics put the unemployment rate in the first quarters of 2013 at 23.9% (Odia and Odia, 2013). The situation of unemployment in Nigeria is indeed alarming (Ogunsola, 2009; Aja-Okorie and Adali, 2013). The graduate unemployment problem has generated several other socio-economic problems in the country manifesting in the following: militancy in the Niger Delta, political thuggery among youths, increased rate of armed robbery and kidnapping and even the Boko Haram saga (Ibe, 2012). The most potent way out of this problem is to go technological entrepreneurship to develop a virile MSMEs sector. Table 5 shows the rate of unemployment in five nations of the world between 2003 and 2011.



b. The need to grow the national economy.

The recent rebasing exercise indicated that Nigeria economy is now the 26<sup>th</sup> largest in the world and the largest in Africa. Recently, Nigeria economy was rated as the third fastest growing in the world. The nation is not far from its target of attaining the 20<sup>th</sup> largest economy by 2020 (Nigeria Vision 20: 2020); there is a need to avoid economic retrogression especially in the light of dwindling oil revenue if we must achieve the objective of Vision 20:2020.

c. The need to create wealth to reduce poverty.

Hunger is an indication of poverty. Globally, one in seven people goes to bed hungry everyday ( International Food Policy Research Institute, IFPRI). Nigeria ranks 40<sup>th</sup> among 118 nations on hunger list based on Global Hunger Index (GHI) Ranking computed by IFPRI (2012). This rating is not too good for a nation who is the largest producer of cassava, yam, melon etc.

d. Incessant Civil/social unrest is an indication of poverty.

Most civil/social unrest activities in Nigeria are carried out by people that are not engaged in profitable ventures/enterprises. These have resulted in very poor rating for Nigeria in the Global Peace Index Rating with country rating of 148<sup>th</sup> out of 162 nations in 2013.

#### 4.3 Things to know in becoming Chemistry Entrepreneurs.

Scientists typically have passion for science, not business; becoming an entrepreneur therefore, requires learning new skills, taking risks and speaking or learning new language or the vocabulary required of an entrepreneur. Scientists also need a basic understanding of the elementary financial structures including basic understanding of balance sheets, cash flow statements, financial ratios and their interpretations and general accounting principles to run business effectively as well as a working understanding of legal topics such as business structures, contracts, liability, and intellectual property; these involve learning a new culture.

Judith J. Albers, Cofounder and Managing Partner of Networks based in New York noted that Scientist who wants to be an entrepreneur must provide answer to the following questions as a way of personal evaluation of their business ideas.

- i. Is there a market need?
- ii. Do you have solution to the market need?
- iii. Does anyone else have the solution?
- iv. Can we make serious money here?
- v. How close are you going to market?
- vi. Do you have a team that can take it to the market?
- vii. Do you have a credible business plan?
- viii. How much will it cost?
- ix. Is this something you really want to do?
- x. Is this the right time in your life?

Albers also offers the following suggestions or pieces of advice to scientists who want to become an entrepreneur:

- I. Understand the market and where your technology fits.
- ii. Be willing to take risk.
- iii. Talk to people who have done this before and build support network.
- iv. Surround yourself with excellent people that you trust.
- V. Don't overlook students when you are setting up business teams.

#### 4.4 Steps to take in Starting a New Business

The following are some identified steps to take in starting a new business; the steps are however, not listed in particular order of occurrence (Oyeku, 2008).

- ☐ Make up your mind as to whether you want to be an employer or an employee.
- ☐ Read up materials on entrepreneurship.
- ☐ Do a thorough evaluation of yourself to knowing whether you can be an entrepreneur.
- ☐ Decide on the type of business ownership.
- ☐ Conduct a thorough research into various windows of investment opportunities without necessarily limiting yourself to a particular area.
- ☐ Select two to three out of the various options of investment opportunities.
- ☐ Get investment profiles on the selected options (if available).
- ☐ Narrow down your choice to one option for a start.
- ☐ Conduct a personal research into the industry to becoming knowledgeable in the industry (e.g.

- competition, raw materials, packaging, machinery and equipment, process technology, etc)
- ☐ Prepare a feasibility report (you can engage a professional but get involved in the preparation).
- ☐ Develop a Business Plan (an extract from your feasibility report).
- ☐ Adopt a name and register your company.
- ☐ Decide on business location.
- ☐ Design your company/product identity package (trade mark/logo, letter headed paper, business card), brochure (information pamphlets), etc.
- ☐ Open a corporate account.
- ☐ Discuss with financial/funding institutions.
- ☐ Develop record keeping/accounting procedure.
- ☐ Contact suppliers of machinery and equipment, raw materials, packaging materials, electricity, water etc.
- ☐ Acquire necessary inputs including building construction/rent/lease.
- ☐ Acquire necessary training.
- ☐ Recruit labour.
- ☐ Locate your market.
- ☐ Conduct trial production.
- ☐ Register your product (if applicable)
- ☐ Open your doors for business.

#### 4.5. Possible Sources of Fund

Balasuriya (2013) enumerated the following windows of opportunities that are available to entrepreneurs to finance their business ideas.

- ☐ Research & Development Grants: Money used for technology development.
  - ☐ Self, family, and friends: These include personal savings of the researcher and funds from interested family members and friends.
  - ☐ Angel investors: An individual who provides networking help, personal insight, and money to early-stage companies.
  - ☐ Venture Capital: Run by a fund manager to provide investment fund to risky business ideas or projects.
- Other sources are: Cooperative Societies; Overdraft or Bank Loans; Hire purchase; Equipment Leasing; Sales of shares and Mortgages.

#### 4.6 Factors militating against Chemistry Entrepreneurship

The factor militating against Chemistry entrepreneurship are the same as those general factors militating against commercialization of R&D results by researchers in Nigeria. Some of these factors as enumerated by Elemo (2014) are presented below:

- i. Lack of financial capability by the researcher to develop the innovation to market place.
- ii. Weak MSMEs sector to further develop the scientific research findings or innovation in collaboration with the researcher into acceptable products in the market.
- iii. Market factor: General apathy for Made-in-Nigeria goods/technologies and high taste of Nigerians for foreign goods including foreign technologies.
- iv. Low level of funding of R&D activities in Nigeria.
- v. Weak linkage between academia and industry.
- vi. Lack of appropriate legal framework on protection and commercialization of innovations.

### 5 THE WAY FORWARD

To ensure effective technology entrepreneurship, this paper makes the following recommendations as the way forward:

- Researchers should make commercialization part of their research agenda from the stage of project conceptualization.
- Researchers should consider the economic aspects of their research projects at conception and the need for strategic partners who will be involved at every stage of the research work and be ready to commercialize them at completion.
- Researchers/Technology developers in developing nations should go beyond prototype levels and build commercial models in partnership with the private sector.
- Government should not just fund research organizations to carry out researches but also invest heavily and consciously on their commercialization.
- Universities and research institutes should build and operate Science Parks and incubation centres to fast track technology entrepreneurship.



- Universities and research institutes should set up Intellectual Property and Technology Transfer Offices to fast track patenting and commercialization of innovation.
- That research organizations, universities, polytechnics etc should partner with organization such as FIRO with success story of commercialization and leverage on its commercialization capability and experience for sustainable economic development through application scientific research results and technology transfer for industrial development.

## 6 CONCLUSION

Chemistry/technology entrepreneurship is needed to take the nation into the next level of industrialization through the small and medium enterprises most especially the attainment of Nigeria's Vision 20:2020 and the national Transformation Agenda. Researchers have to be up and doing and be more active in market driven R&D activities that would end up being commercialized.

Even though, Chemistry entrepreneurship is a personal choice of individual Chemist or researcher, this paper makes a clarion call for chemistry entrepreneurship for the sake of the nation Nigeria; the economy is nose diving at an alarming rate! We probably cannot boast that 20% of graduates of Chemistry from various Universities are gainfully employed! This is the time for the nation just like it was done in US to turn to its universities and research institutes to bail it out. The onus therefore, lies on the universities and research institutes to start devising solutions and workable programs that will take the nation out of the economic doldrums.

The nation must begin to take research and development very seriously and imbibe the culture of solving national problems including economic problems using the instrument of science and technology.

The education and the economy of the 21<sup>st</sup> century must be driven by entrepreneurship. The National Universities Commission of Nigeria is taking the lead in promoting entrepreneurship education in tertiary institutions in Nigeria but the authors of this paper think that we should begin to have specialized universities: research-based, teaching-based and entrepreneurial universities. At this critical state of the economy, what is needed is more of entrepreneurial universities and adequate motivation of scientists (academic staff and students inclusive) to move their innovations from the laboratories to the market place through patenting of innovations.

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