Industry- Academia Collaboration through Cloud Computing: A Pathway for Sustainable Development in Developing Countries

J.O. UGAH[1], M. E. IGBOKE[2]

1 Department of Computer Science, Ebonyi State University, Abakaliki-Nigeria
2 Department of Computer Science, Ebonyi State University, Abakaliki-Nigeria

Abstract: *Industry-academia collaboration through cloud computing recommends partnership through a subscription based service platform that enables each party to obtain networked storage space and computer resources as well as transacts businesses through those computer resources. This approach is unique when compared to the existing collaboration system that rides on traditional enterprise computing. The motivations for this approach are budget pressures, need for universities and industries to help in solving the immediate problems of the host communities, need for institutions to provide timely access to the latest information technology facilities and functionalities. The benefits of this approach are that institutions would only pay for the resources used, and users can access the applications and files they need from virtually any Internet-connected computer. Researchers would be able to extend their research to a level of yielding reasonable results that would help in solving real-life problems of the immediate society and bring about sustainable development in developing countries. The industry would also gain knowledge and technical expertise from experienced professors more often than before and would also have the privilege of making input to the lives of students and researchers who are the potential staff members of the industry.*

Keyword: *academia, collaboration, cloud, development, Industry, sustainable*

I.   Introduction

University is the breeding ground for the workforce of every nation. The University of any Nation has the responsibility of training and developing man power in different fields of study that will manage the economy of that nation. The university is also charged with the added responsibility of liaising with the existing industries to conduct researches and come up with tested and reliable inferences (results) that would form the bases for solving the problems of the common man in the immediate environment. In order for the university to live up to these responsibilities, it must be well equipped with both human and material resources. They should be standard facilities for teaching and learning. They should also be an enabling environment for research and community development. Furthermore, the present day economy is information driven economy and to prepare for this society, knowledge workers need to have more general knowledge and to learn with less support [1]. There should therefore be robust information technology facilities to help place students and lecturers in the developing countries on the same page with their counterpart in the developed countries. To put in place resources that would bring about this interaction is never without cost. Universities and industries should therefore look out for an easy and cost effective way of achieving best results. One of the ways through which both parties could achieve this effectiveness and efficiency is through collaboration.

Most developed countries of the word are already having a robust tradition of collaboration between their universities and the industries [2]. However, in the developing countries, such collaboration is still tender due to some factors.   In recent time, most universities and industries in the developing countries are beginning to see the need to collaborate with industries to enable them draw some benefits. Furthermore, most of the universities especially those of the developing countries are faced with pressure for quantitative and qualitative expansion with stagnating or diminishing public resources [3]. According to [4], universities draw some benefits by collaborating with industries:

(i)   Collaboration gives the universities the opportunity to attract added funds for both teaching and research. Funds attracted will in turn help to boast the financial autonomy of such universities and reduces sole dependence on the government [5]

(ii) Synergy between universities and industries would also offer students and staff the privilege to become familiar with the-state of–the- art industrial sciences and technology.

(iii) Collaboration also improves training and employment opportunities of the students.

(iv) It also promotes and enhances the image of the university [6]

(v)   It makes for additional income from consulting thereby helping academic staff to improve their salaries [7]

(vi) The synergy would also improve interaction of the different employers for the development and adaptation of technology oriented programmers.

(vii) It gives universities access to up-to-date equipments.

In spite of the benefits identified above, the university's main mission for collaboration has always been the need to supply highly educated and trained people to work in government, public and industrial institutions. For the industries, collaboration with the universities gives such industries the opportunity of gaining access to complementary technological knowledge, tapping into a pool of skilled workers [8]. It also helps in providing training to existing and/or future employees. Synergy also helps them in gaining access to university facilities and equipment and gaining access to public and incentives. It further provides industrial researchers a way to test the validity of their own thinking and directions.

II. Previous Works

Academic institutions act as an essential driver of economic development of any nation through her role in teaching and technology absorption, adaptation and diffusion. [3] Stated that the existence of relationships between higher institutions and industries became a common and widely acceptable phenomenon from the late nineties. It was noted that at that time, information on such successful business ventures was easily available as part of an information and communication strategy conducted by these institutions. Technological advancement has also brought about enhanced approach to information sharing even among higher institutions and industries collaborating together.

2.1 Types of university- academia collaboration

According to [9], collaboration may be formal or informal. They also added that collaboration can either be short term or long term. In the case of short term collaboration, on-demand problem solving approach with predefined results is adopted. This type is always articulated through contract research, consulting and licensing. Long term collaboration involves the two parties having joint projects and public-private partnerships. This kind of collaborations are more strategic and helps to provide a multifaceted platform for firms to develop a stronger innovative capacity in the long run building upon the capabilities, methods and tools of universities [10].

In both developed and developing countries of the world, different types of university – industry collaboration has been identified. Some of the common once include:

(i) Collaboration in continuing Education: sequel to the fact that the major role of academic institution is teaching, institutions has the courseware and capacity to provide training for high –end manpower development [11]. The industries in most cases do need some of these topics and teaching to help them execute their jobs or produce their products. The universities sometimes may have a need to go for short term courses in some faculties of the company. These needs bring universities and industries to collaborate for mutual benefits. Also, the effectiveness and output of working professionals in both parties will be enhanced when they collaborate.

(ii) Collaboration in Research: Here, the major reason for collaboration is research. In addition to teaching, the university is also saddled with the responsibility of developing new knowledge in research that will directly or indirectly help in solving the problems of immediate environment. Collaboration with industries will help the universities secure more funds to conduct researches and also gives them access to empirical data from the industries easily. For the industries, the collaboration helps them to gain access to complementary technological knowledge and seeks to reduce risks by sharing the costs of research and development [12].

(iii) Producer-consumer Interaction [11]. Here the relationship is a situation where one party produces while the other party is the consumer/user of the product. It may just be a kind of feed back loop where an industry provides input back to the academic institutions regarding the institution's observations in a given industry's product. In some cases, this kind of collaboration does not occur in a well structured manner. Both side will s just maintain a distant relationship.

Apart from these three types discussed briefly above, whenever universities and industries sees some good reasons to partner together, they may engage in a form of collaboration.

The benefits of university-industry collaboration are clearly evident in some developing countries. [12] explained in his work that the study he carried in some developing countries such as Colombia shows that academia-industry collaboration substantially increase the propensity of firms to introduce new product and to patent. It is also worthy of note that in developing countries, a major concern which would bring about collaboration is the poor quality of education and the lack of financing available to the universities. This need in most cases drives the universities to looking for make-up funds from external agents.

In spite of many benefits accrued to academia- industrial collaboration, there are some known barriers and challenges for collaboration. Some of the conflicting issues are summarized in the table below

Factor	Industry	University	Remarks/solution
Output	Industries are interested in how quickly new patents or new products can be obtained	University researchers are basically motivated to publish research results as fast as possible	They must establish a common ground to operate
Inherent Mismatch	Industries focuses on fast commercial results	Universities focuses on basic research	Collaboration still yields result but at the long run
Intellectual property (IP) Right	Industries are concerned about misalignment of expectation with regards to intellectual property rights and making a profit from them [12]	Researchers in the universities are concerned first in making discoveries of new knowledge and to publish them.	Agreements must be reached in a timely manner that establishes and ensures the ability of each party to deliver.
Recommendations: Functional and successful industrial-academia collaboration should therefore avoid conflict with the mission of either party. They should from the word go streamline negotiations to ensure timely conduct of the research and the development of the research findings.			

Table 1: some conflicting issues in academia-industry collaboration and the way out

2.2 Concept of sustainable Development

Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs [13] explicitly explained that sustainable development as the ability of any economy to support the needs of the people of a country over a period of time taking into consideration the economic, social and ecological constraints of that country. From this explanation, it follows that for development to be sustainable, it should embrace at least three basic components. These components include:

(i) A development that is sustainable must support the needs of the people of a given economy at a given time.

(ii) A sustainable development must not bring about anything that would cause a harm or damage to the environment [14]

(iii) A sustainable development must have some limits because the achievement of sustainable development requires the integration of not only its economic, but also its environmental and social components at all levels [15]

It is important for us to establish here that development is not only good but also necessary. In view of this, the basic issue to look at would be how to achieve this development in a way that allows future generation to keep using the resources we use today. Although some people think that our forefathers never cared much about us when they developed, it is imperatives for us to balance certain factors when we are pursing development to avoid having serious consequences in the near future.

Universities have made various landmarks in the process of designing approaches and mechanisms to bring about sustainable development in the host environment [3]. However, many of them have not succeeded in fully implementing the principles of sustainable development into practice due to a combination of reasons, varying from lack of institutional interest, to limited resources. To fully implement the principle of sustainable development therefore, we recommend that universities should collaborate through a proactive and cost effective means such as cloud computing.

III. Methodology

The methodology recommended for the industry-academia collaboration is cloud computing methodology. This is different from the tradition enterprise computing approach that has been used over time. There are different types of cloud that can be considered for use such as the private cloud, public cloud, hybrid cloud and community cloud. For this case study, we considered community cloud the best option. This is because community cloud is a multi-tenant cloud service model that is shared among several or organizations and that is governed, managed and secured commonly by all the participating organizations or a third party managed service provider [16]. The goal of community cloud is to have participating organizations realize the benefits of a public cloud with added level of privacy, security and policy compliance associated with private cloud. Community cloud platform if used for industry-academia collaboration will give room to both the industries and the universities involved to gain access to share resources and exchanged services under high secured environment with minimal intrusion from outsiders.

IV. Discussions

From our discussion so far, it is clear that collaboration between academia and industries is increasingly a critical component of efficient national innovation systems. Although it is clear that collaboration between these two parties would bring about mutual benefits among them and help catalyze sustainable development, developing countries particularly need a strategy that is easy, innovative, and cost-effective in order to sustain the collaboration to a point of reaping these benefits. Cloud computing will provide the enabling environment that developing countries can easily cope with.

4.1 Cloud computing as a better approach to industry-academia collaboration

In the earlier part of this paper we establish the fact that industry-academia collaboration is paramount for economic development of any nation. However, it should be noted here that such alliance is never cost-free. It does cost both the university involved as well as the industry something for both parties to be in such alliance. Collaboration through cloud computing promises cost- effectiveness, efficiency, and reliability and secure transactions between the parties. We shall therefore concentrate this section in discussing what cloud computing is all about, how it works, the different services one can enjoy. We shall pay particular attention to how cloud computing will help sustain industry-academia collaboration to a point of bring about sustainable development. Cloud computing is a subscription-based service where you can obtain networked storage space and computer resources [17] . In Cloud computing, scalable information technology resources and storage space are delivered over the Internet. These recourses include applications, services as well as the infrastructure and services over the network. Usually an individual or organization can purchase these resources on an-as needed basis and by so doing avoid the capital costs of software and hardware. [18] Explained that with cloud computing information technology capacity can be adjusted quickly and easily to accommodate changes in demand. This is far better and more cost-effective when compared to the traditional enterprise computing. In traditional enterprise computing, IT departments forecast demand for applications and capacity and invest time and money to develop those resources in-house or purchase them from others and operate them in-house.

4.2 Significance of cloud computing

Many advantages abound for using cloud computing in industry-academia collaboration. Some of these advantages includes among others the following:

(i) Cloud computing helps organization present Information technology with a fundamentally different model of operation [19]. It utilizes the maturity of web applications and break through in the computer world to provide better computing services

(ii) Cloud allows for efficient management, upgrade, maintenance, disaster recovery, failover functions and thereby bringing about increased reliability and cost minimization [19].

(iii) According to [20], cloud computing also helps organizations to monitor current needs and make as-you-go adjustments to increase or decrease capacity and reduces paying for unused capacity.

(iv) Cloud computing helps universities gain the flexibility of being able to respond quickly and spontaneously to requests for new services by purchasing them from the cloud.

(v) Scalability is another key features of cloud computing. This feature provides another benefit for the universities using cloud computing. It particularly offers help for research projects that require vast amount of storage or processing capacity for a limited time.

(vi) Cloud computing encourages IT organizations and providers to increase standardization of protocols and processes so that the many pieces of the cloud computing model can interoperate properly and efficiently [21]

(vii) Cloud computing helps IT providers to make IT cost transparent and by so doing match consumption of IT services to those who pay for such services [20]

(viii) With cloud computing, software is hosted by the cloud provider and does not need to be installed or maintained on individual computers around campus. In addition, institutions pay only for the resources used and users can access the applications and files they need from almost any Internet-connected computer [5].

(ix) Cloud computing helps an institution to increase operational efficiency and focus scarce resources on services that makes an institution unique.

(x) Cloud services are more easily accessed by both students and members of staff of an institution.

4.3 Types of Cloud Providers

There are three types of cloud providers that one can subscribe to. The providers include: software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS) [22]. These three types differ in the amount of control that you have over your information, and on the contrary, how much you can expect your provider to do for you. Discussed below is what you can expect from each type of cloud provider.

1. Software as a Service - A software-as- a- service (SaaS) provider gives subscribers access to both resources and applications. SaaS makes it unnecessary for you to have a physical copy of software to install on your devices. SaaS also makes it easier to have the same software on all of your devices at once by accessing it on the cloud. The services offered software as a service cloud providers is quite essential in promoting industry-academia collaboration. This is because since with this service, it becomes unnecessary for you to have a physical copy of your software installed on all your devices, it brings about convince and reduction in both time wastage and cost. Updating of licensed software also becomes an easy task since it would mostly be done through one end.

2. Platform as a Service – A platform-as-a service (PaaS) provider allows the creation of web applications quickly and easily and without the complexity of buying and maintaining the software and infrastructure underneath it [23].PaaS system goes a level above the Software as a Service setup. A PaaS provider gives subscribers access to the components that they require to develop and operate applications over the internet. This again is very useful to both the industry and the university that are collaborating together. Since you now have access to the components you require developing and operating applications, It would be easier for both industry and university researchers to do real research with minimum distractions.

3. Infrastructure as a Service – An Infrastructure as a Service (IaaS) provider delivers cloud computing infrastructure – servers, storage, network and operating systems – as an on-demand service. Rather than purchasing servers, software, datacenter space or network equipment, clients instead buy those resources as a fully outsourced service on demand [24]. In an IaaS agreement, the subscriber completely outsources the storage and resources, such as hardware and software that they need. Infrastructure as a service is greatly needed for industries and universities to effectively collaborate.
On the overall, cloud users are allowed by the providers to choose their level of control over his information and the type of services he wants from the service provider.

4.4 Cloud computing benefits for industry-academia collaboration
　　　　Cloud computing offers a lot of benefits to subscribers. However, the organizations concerned should structure their operations in such a manner that they can best use the architectural and deployment paradigms that cloud computing supports. Some of the specific benefits that cloud computing offers include among others the following:
(i)　　　　**Cloud computing helps to minimize infrastructural risk:** In tradition enterprise computing each organization is saddled with the responsibility of designing the IT infrastructural needs. The organization in turn develops these IT infrastructures in-house or procures, install and maintain. Cloud computing removes the risk of purchasing too much or too little infrastructures to cloud providers. With this infrastructural risk released to cloud providers, scalability needs is as well the duty of cloud providers.
(ii) **Cloud computing Lowers cost of entry:** From the point (i) we see that infrastructure is rented, not purchased. The cost is controlled and capital investment can be zero [24]. Also the massive scale of cloud providers helps to minimize cost, helping to further reduce the cost of entry.
(iii) **Cloud computing Increases Pace of Innovation:** Due to low cost of entry which cloud computing provides, it helps to level the playing field, allowing start companies and newly established and not well funded universities to fit into the business of the day.
(iv) **Cloud computing helps to reduce run time and response time:** Since IT infrastructure is usually provided by cloud providers, subscribers would likely have the opportunity of using many servers at the same time. This feature would help organizations, universities having bulky or even batch jobs to accomplish execution of such jobs in few seconds thereby reducing run time and as well as response time.

4.5 Security issues to consider while using the cloud
　　　　Security is usually a major concern for all cloud users. A manager of an organization who uses tradition enterprise computing is already conversant with having full control of all information stored and processed locally within the organization. In traditional approach, users typically operate inside a secure perimeter protected by a corporate firewall. Information on the Internet including the cloud is no longer being processed and stored in one location like that of the traditional computing enterprise. Because these information travel from one location to another, it becomes vulnerable to attack by hackers. It becomes necessary for all cloud subscribers to understand the security measures that their cloud providers have in place. In addition, it would also be good for all cloud users to take some personal precautions.
　　　　The first thing to do is to ensure that the contract between you and the cloud service providers should do the following [25] (i) state explicitly the cloud provider's obligation to securely handle sensitive information and its obligation to comply with privacy law. (ii) spell out the cloud providers' liabilities' for mishandling sensitive information. (iii) Spell out cloud providers liabilities for data loss, (iv) spell out rules governing the ownership of data, (v) specify the geographical regions where information and backups can be stored.
In addition, all cloud subscribers should try to take the following measures since data is often the most valuable of a company's assets and must be protected.
(i)　Encrypt data at rest so that if any intruder is able to penetrate a cloud provider's convenience security, the data cannot be interpreted.[26]
(ii)　Encrypt data on transit whenever such data would pass over public infrastructure and could be observed by third party.

(iii) Insist on strong authentication between application components so that data is transmitted only to known parties.

(iv) Pay attention to cryptography and how algorithms are cracked and are replaced by new ones over time [25].

(v) Monitor customer's login/password access. Consider who manages the authentication server and whether is the company or the cloud provider's control

V. Conclusion

From our experience as academics, we have come to appreciate the strategic position the university and the industry occupy especially in the developing countries. We have come to know that the University is saddled with the responsibility of grooming the populace to help them fit into the economy. Another basic role of the academia is research. Research brings about new knowledge and discoveries in different subject areas. The discoveries made in research is used by the industries in building products that in turn help to address the immediate problems of the larger society. Industries on the other hand make use of the knowledge and technologies discovered both by their technical staff and researchers from the universities in building and developing various products that brings about sustainable development in any nation. In developing countries like Nigeria, most researches done does not really translate to practical and practicable principles, techniques, theories, laws and even goods/products and services that would provide solutions to the problems of a common man in the society. The reason for this situation is basically due to the fact that most universities in the developing countries are not well funded. Effective collaboration between academia and the industry would bridge this gap and would help researchers extend their research to a level of yielding reasonable and useful results that would help in solving real-life problems in the society. The industry would also benefit by tapping knowledge from experienced academics. They would also have the privilege of making input to the lives of those who may eventually become potential staff member of the industry and would help to man some critical sectors of the industry. To make these envisaged benefits real to the common man and the society at large, a proactive approach to collaboration such as cloud computing should be adopted. This approach is most suitable in our highly interactive and information driven society. Cloud computing will help foster a functional collaboration between industry and the academia and would help both party in fulfilling their crucial roles in the economy especially in the developing countries.

References

[1].   P.W. Beverly, Building intelligent interactive tutors, student-centered strategies for revolutionizing e-learning (Morgan Kaufmann Publishers San Francisco London 2009). Pp. 1-10, 11-23, 49.

[2].   M.M. Michaela, Managing university-industry relations, a study of institutional practices from 12 different countries. international institute journal for educational planning (Rue Eugene Delacroix 75116 Paris, 2000). 7(9), Retrieved online on at: http://www.unisco.org/iiep.

[3].   L.F. Walter, about the role of Universities and their contribution to sustainable development. International association of Universities. (2011). Online from http//:www.palgrave.journal.com./hep/

[4].   D.J. Michael, Collaboration between the academic world and the industry, an interview with Prof Dr. Michael Junger. Elsevier, 2009. 5-9

[5].   P. Yusuf, University-industry links; policy dimensions in how universities promote economic growth, 2011. Retrieved online on 20th May 2015 at : http://demo.netcommiabs.com/innovation/pdf

[6].   P. Jonathan, M. Stev, E. Bruce, H. Elizaberh, and A. Stuart, Collaboration between universities: An effective way of sustaining community-university partnership. International journal of research, 2008 . Retrieved online on 10th febuary, 2015 at : http://dx.doi.org/10.5130/ijcre.v4i0.1773

[7].   R. Anderson, and C. Nelson, Collaboration in distance education: Ontario's Contact (North/Contact Nord Canada 1989), 209–210.

[8].   J. Hagdoom, N. Link, and S.Vonortas, Research partnership, research policy, national policies to attract research and development incentives in developing countries. (2000).

[9].   K. Koschatzky, and T. Stahlecker New forms of strategic research collaboration between firms and universities in the German research system, International journal of technology transfer and commercialization. 2010.

[10].   J. Pankaj, Challenges in industry-academia collaboration, unpublished note from pankaj Jalote, (2000). Dept of CSF IIT Kanpur.

[11].   J. Guimon, Promoting university-industry collaboration in developing countries: The innovation policy platform, 2013

[12].   O.Ayodele, Building sustainability science curriculum in Nigeria, accommodating local adaptation leveraging technology and enhancing areas of improvement for quality assurance 2007, Paper presented at the proceeding of the Science Teachers Association of Nigeria.

[13].   http://www.articlesbase.com/nature-articles/sustainable-development-for-developing- countries-174628.html.

[14].   http://www.un.org/esa/dsd/index.shtml?utm_source=OldRedirect&utm_medium=

[15].   redirect&utm_content=dsd&utm_campaign=OldRedirect

[16].   M. Dan, Cloud computing: theory and practice. Elsevier Inc. 3 Jansen, (Wayne Street, Waltham, 02451, USA 2013).

[17].   A. Tanenbaum, and S. Van, Distributed systems: principles and paradigm (Upper Saddle River, NJ, USA: Prentice Hall PTR; 2001)

[18].   Y.Wang, and. C. Wang, Large-scale social intelligence reasoning on cloud, 2010." Proc IEEE 2nd Int. Conf. on Cloud Computing Technology and Science , pp. 529–536, 2010.

[19].   H. Strowd, and G. Lewis, Cloud Computing,check in System-of-Systems Technologies: CMU/SEI-2010-TN-009 (Carnegie Mellon University, 2010). http://www.sei.cmu.edu/library/abstracts/reports/10tn009.cfm

[20].   H. Alexa, and C. James, The NIST definition of cloud computing at United State computer Emergency Readiness Team US-CART ,(2011). online at http://csrc.nist.gov/publications/drafts/800-145/Draft-SP-800-145_cloud-definition.pdf.

[21]. G. Lewis, Basics about cloud computing, lecture note, 2010. retrieved online on 15th January, 2015 at http://www.sei.cmu.edu/library/abstracts/whitepapers/cloudcomputingbasics.cfm

[22]. [B. Rajkumar, C. Vecchiola , and S. ThamaraiSelvi, S. Mastering cloud computing, foundation and applications programming. (Elsevier Inc.SAN FRANCISCO. 222 WymanStreet, Waltham, MAO2451, USA. 2013)

[23]. G. Lewis, Cloud computing findings the silver lining, not the silver bullet,2009, retrieved online at: http://www.sei.cmu.edu/newsitems/cloudcomputing.cfm

[24]. B. Anderson, A system for public-resource computing and storage, Proceedings of the fifth IEEE/ACM international workshop on grid computing. Pittsburgh, PA, USA: 2004.

[25]. Amazon Web services: Overview of security processes." http://s3.amazonaws.com.

[26]. T. Andrei, Cloud computing challenges and related security issues, 2012 at http://www1.cse.wustl.edu/jain/cse571-09/ftp/cloud/index.html.