Industry-Knowledge Institutions Collaborations in Nigeria: Critical Issues and Policy Directions

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ABSTRACT

The paper discusses collaborative activities among Nigerian science and technology researchers and industrial firms. The study, which focused on the fields of Agriculture, Science and Technology, revealed that majority of the researchers conduct applied research, most of which is demand-driven. The study found that the researchers collaborate mostly with local research agencies, followed by industrial firms and thirdly with international research agencies. Furthermore, the firms in one way or the other have supported about 36% of the researchers. Inadequate research facility that could satisfy research needs of the firms was a major constraint that prevented the firms from patronising the researchers. The establishment of central laboratories in selected universities and the need to market research outputs of university to industry are suggested to address the challenges.

Keywords

University, industry, research, collaboration, Nigeria

1. Introduction

Nigeria, Africa's most populous country with estimated 150 million people, has a land area of 910,768 sq km and is blessed with several mineral resources. The vegetation of the country is diverse, ranging from mangrove forest in the south to arid land in the north. Agriculture was the major mainstay of the Nigerian economy, with farm products such as cocoa, palm oil, cotton, groundnuts among others, the major export commodities. However, since the 1970s, when petroleum was discovered in commercial quantities in Nigeria, crude oil rose to the forefront, and now provides about 20% of GDP, 95% of foreign exchange earnings, and about 65% of budgetary revenues for the country. Starting with one university during the colonial period, Nigeria now has 104 universities. Industrial firms of various scales and ownership structures have also been established in the country.

Collaborations between industry and knowledge institutions such as universities are crucial to the continuous survival of industrial firms, because the institutions assist the firms to resolve their problems and to develop new products. As Meyer-Stamer (1995) hinted, either firms carry out research to innovate, or they will liquidate. Research and development (R&D) activities are expensive ventures as they involve large investments in laboratory facility and employment of highly qualified researchers. However, collaborating with knowledge institutions such as universities and research institutes could ensure continuous supply of innovative ideas to industrial firms. Consequently, industry-knowledge institutions' collaborations have been a crucial policy issues that border on technological development and management.

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In the course of their activities, researchers collaborate with colleagues in their institutions, other establishments and industrial firms. Such collaborations could be in research projects and other incidental activities. An earlier study on the interactions among the key elements of Nigeria's National Innovation System (NIS) by Oyewale (2005) focused on three industrial sectors. The study indicated that about 25% of researchers interacted with industrial firms in terms of information/knowledge exchange, while about 38% based their research activities on ideas brought by industrial firms. Furthermore, about 40% of the industrial firms supported research activities in universities and research institutes and had idea inputs into research activities of institutions. In a study of R&D productivity of Nigerian researchers, an attempt was made to assess collaborative activities between researchers and industrial firms. The report of the study is presented in this paper.

The paper is divided into seven sections. Section 1 is the introduction to the paper, while Section 2 is a brief literature review of the topic under consideration. The research focus is Section 3, section 4 gives a description of the methodology employed for the study, while section 5 is the discussion of the findings of the study. Section 6 is the contributions of the study, while policy implications are discussed in Section 7.

2.   Literature Review

R&D comprises creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications (OECD, 2002). Research activities may be divided into two broad types: basic and applied. Basic, scientific or fundamental research is the study, experimentation, conceptualisation and theory testing involved in making discoveries or developing new applications (UNESCO, 1979). Basic research creates knowledge that expands human understanding of nature (Branscomb, 1997) and provides most of the original discoveries and hypotheses from which technological progress flow (CSP, 1967). Applied research or experimental development consists of the processes of adaptation, testing and refinement, which lead to practical applicability of the knowledge. Applied research is conducted with social objectives and it concentrates on developing technologies with specific applications that are meant to solve specific product and/or process problems (Rothschild, 1971).

Traditionally, universities engage in teaching and conducting basic research for the generation of scientific knowledge without any particular application or use in view, while industry focuses on applied research for production of goods and/or services. These differences made industrial firms to have little reliance on universities as sources of information or stimulus for their innovative efforts for a long time. Consequently, universities and industry hardly interacted.

However, the usefulness of university research for industrial development was better realised during the Second World War, when the United States of America (USA) and other countries invested heavily in scientific research conducted in universities. Since then, universities started engaging in the development of technology for commercial purposes (The World Bank, 2007). Bremer (2001) noted that technological demands imposed by increasingly sophisticated military requirements for the prosecution of World War II and the ensuing need for technological superiority of the USA, at least in defense-oriented efforts after the war, encouraged American government to continually fund university research to develop new technologies. Since then industry intensified

its interactions or collaboration with universities for new product development. Hagedoorn (1993) noted that such innovation-based research relationships involve, at least partly, a significant effort in R&D.

In realisation of the potentials of university research, R&D has become a major formal collaborative tool between the industry and the university, especially to develop new products and resolve product and/or production process challenges. To achieve these, industry had been funding R&D activities in the universities. OECD (1998) indicated that business funding of R&D in higher education in the OECD countries rose steadily between 1980 and 1995. This resulted from increasing dependence of industries on researches of universities. The publication also hinted that the decline in government funding of R&D in the institutions forced them to search for alternative sources of R&D finance, such as contract research and income from patents. With collaborative efforts, industrial firms can exploit inventions that educational institutions and research institutes generate.

Industrial funding of university R&D activities is achieved through contract and sponsored researches, which universities researchers enter with industry. Under such collaborative activities, the researcher works on industry's research project without quitting university's employment. Taylor (1994) indicated that pharmaceutical firms spend about 10-20% of their total R&D budget on such sponsored and collaborative researches with universities and research institutes.

The major reasons for collaborations in the 1980s and 1990s were to reduce the development cost, minimise risks of failure, achieve economies of scale in problem solving and speed up the innovation process (Hagedoorn, 1993; in Numprasertchai and Igel, 2005). While these reasons are still valid, today, collaboration focuses on the knowledge perspectives such as sharing, exchanging, and integrating knowledge to overcome barriers to achieve research goals (Carayannis et al., 2000; Hagedoorn, 1993; Parker, 2000; Tidd et al., 1997; in Numprasertchai and Igel, 2005). This is what interactions of the elements of the NIS aim at achieving.

The NIS is the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies (Freeman, 1987). System in this perception implies a dense tissue of relationship among the various organisations and individuals that make up the NIS. Therefore, to function effectively, the elements of the NIS have vertical and horizontal interactions among themselves. Furthermore, innovative performance of national economies depends on how individual organisations in the countries perform in isolation and how they interact with other elements of the system. Therefore, performance of universities and research institutes in knowledge creation, firms in the utilisation of the knowledge, and the interplay of these organisations with other institutions would influence innovation in a country. Consequently, collaborative activities of universities with industry can be adequately studied within the NIS framework.

In their paper, Dzisah and Etzkowitz (2009) designated Triple Helix as a development thinking of the 2000s and described the model as having the following three features:

     i.   a more prominent role for the university in innovation, on a par with industry and government in a knowledge –based society;

ii.   a movement toward collaborative relationships among the three major institutional spheres in which innovation policy is increasingly an outcome of interaction rather than a prescription from government; and

iii.   in addition to fulfilling their traditional functions, each institutional sphere "takes the role of the other" in some regards. e.g. university taking government's role of initiating development projects or industry's role of firm formation.

The NIS as described by the Triple Helix concept recognise three key elements – Government; Academia and Industry. However, Tiffin (1977) suggested Finance as a fourth element of the NIS. Therefore, interactions of the elements of the NIS can be depicted as that shown in Figure 1. Each of these elements has its own unique roles, which, however, depend on adequate performance of the others for its success.

In Nigeria, there are 27 federal, 36 state and 41 privately owned universities. R&D is conducted in these 104 universities with varying capacities for pure and applied R&D (NUC, 2009). In addition, 71 polytechnics, 36 colleges of agriculture and specialised technological institutions, and 27 monotechnics have modest efforts in applied research (NBTE, 2009), while 66 research institutes and few industrial firms have R&D programmes targeted at the different sectors of the economy (Bamiro et al., 2008).

Multinationals, foreign and indigenous investors have established industrial production factories of various sizes and with various structures of ownership in Nigeria. The industrial firms are categorised by the Manufacturers Association of Nigeria (MAN) into ten (10) sectoral groups using the Standard International Trade Classification (MAN, 1994).

Reports on earlier studies on interactions among the elements of Nigeria's NIS indicated weak collaborative activities between the knowledge institutions and industry. For instance, Oyewale (2005) indicated that about 25% of the researchers interacted with industrial firms with information/knowledge exchange, but such interactions were more prominent among researchers in Food Science and Technology Departments. The study further revealed that less than half of the researchers interacted with industry with material/equipment usage, while interactions involving financial interactions were hardly reported by the researchers.

Another important aspect of research-industry interaction is provision of research idea/problem by industry to the researchers. The study revealed that about 38% of the university researchers based their research activities on such ideas, most of which were offered by indigenous firms. Furthermore, about 40% of the industrial firms claimed to have had idea inputs into research agendas of institutions/institutes and researchers.

3.   **Research Focus**

The research focus of the study herein reported is the evaluation of the collaborative activities of Nigerian researchers and industrial firms with a view to identifying critical issues that need policy intervention. Earlier study on Nigeria's NIS by Oyewale (2005) identified information gaps within the system and concluded that interactions between knowledge institution and industry were too weak to bring about innovations and knowledge-based industrial development in the country.
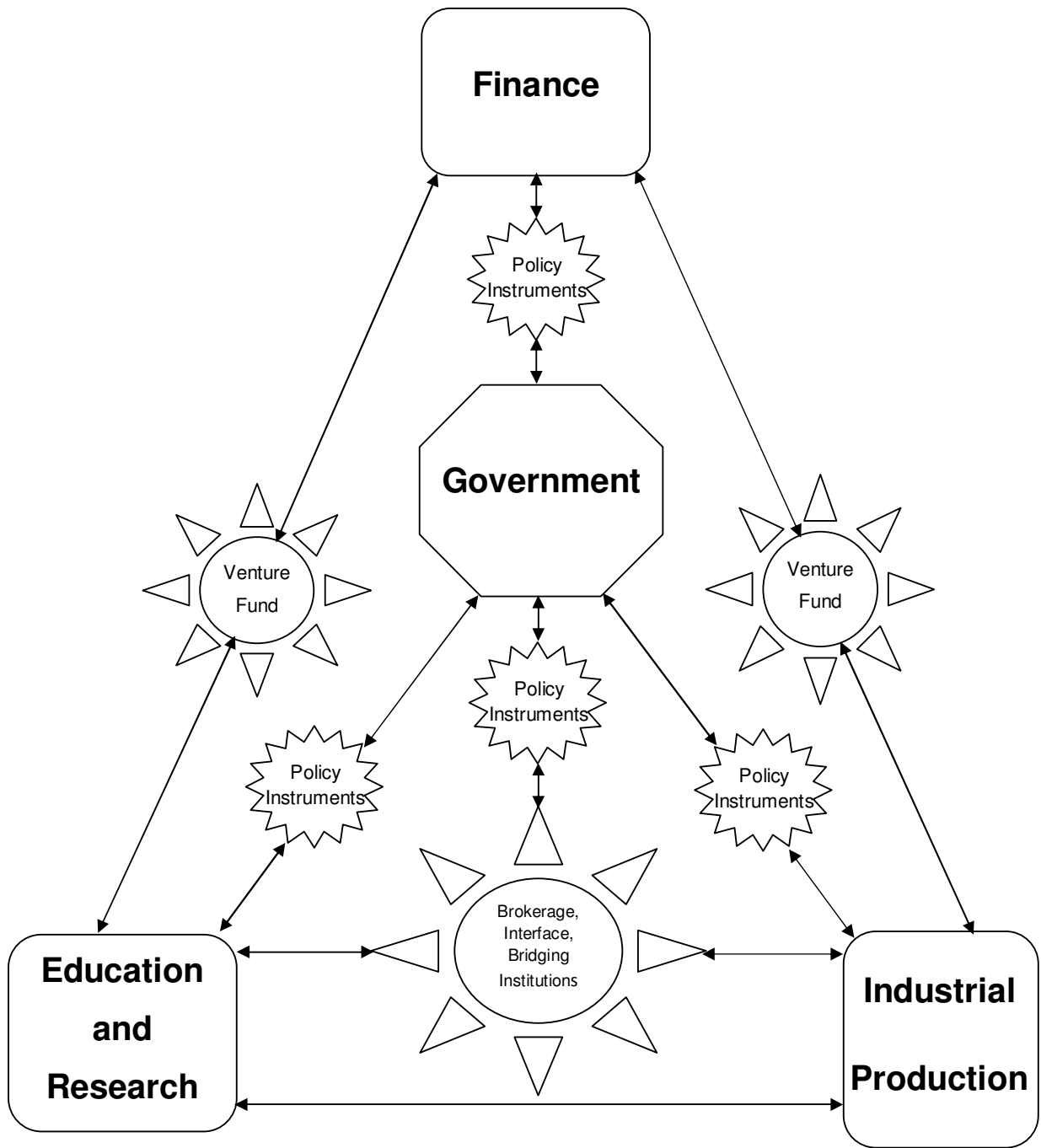
Figure 1: Typical Structure of Interactions among the Elements of the National

However, since the time the study was conducted, new developments had occurred in Nigeria. For instance, the Federal Government of Nigeria had implemented a programme on the reform of the National Science and Technology System, and Intellectual Property Technology Transfer Offices have been established in some universities and research institutes. This study was therefore conducted to obtain a situation report on collaborative activities between the institutions and industry.

4.   Research Methods

Primary data for this paper were sourced from a policy research project conducted by the National Centre for Technology Management (NACETEM), Nigeria, titled Assessment of R&D Productivity in Nigerian Universities and Research Institutes (NACETEM, 2009a). A questionnaire to elicit information on researchers' collaborations efforts, types of supports received from the industry and barriers to R&D engagements was designed for the study.

Ten leading Nigerian universities made up of seven (7) Federal, two (2) State and one (1) Private-owned institution were purposively selected for this study. A map of Nigeria indicating the locations of the universities is shown in Figure 2. The selected universities were:

i.   Ahmadu Bello University, (ABU) Zaria, Kaduna State;
ii.   BABCOCK University, Ilishan Remo, Ogun State;
iii.   Enugu State University of Technology, (ESUT) Enugu State;
iv.   University of Nigeria, (UNN) Nsukka, Enugu State.
v.   Ladoke Akintola University of Technology, (LAUTECH) Ogbomosho, Oyo State;
vi.   University Of Ilorin, (UNILORIN) Kwara State;
vii.   University of Maiduguri, (UNIMAID) Borno State;
viii.   University of Benin, (UNIBEN) Edo State;
ix.   University of Ibadan, (UI) Oyo State;
x.   Obafemi Awolowo University, (OAU) Ile Ife, Osun State.

In all, 457 copies of the questionnaire were randomly distributed to lecturers in three fields of study in the 10 institutions. By the end of the study, 274 (60%) copies were retrieved; 107 (39.1%) from Agriculture, 84 (30.6%) from Science and 83 (30.3%) from Engineering/Technology. The data were analysed using Statistical Package for Social Sciences (SPSS).

Secondary data were sourced from another policy project of NACETEM – Assessment of Innovation Capability in the Manufacturing Sector in Nigeria (NACETEM, 2009b). The data from these two studies were compared with the results of Oyewale (2005) and form the basis of this paper.
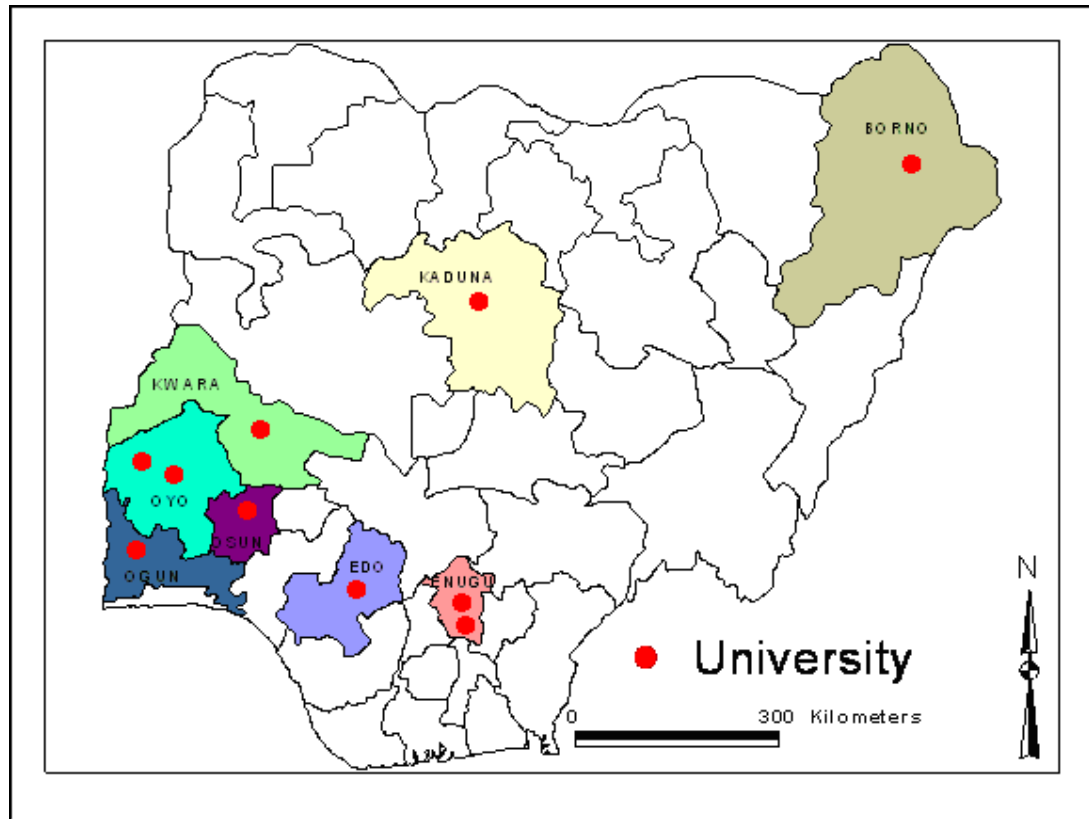
Fig. 2: Map of Nigeria showing location of the Universities

5.   Results and Discussion

Almost all the researchers from Faculties of Agriculture and science claimed to conduct basic/fundamental research, while 61% of the researchers from the three faculties claimed to conduct applied research. In addition, about 54% of the researchers claimed that their researches were market-driven. This figure shows a marked improvement on about 38%, which Oyewale (2005) reported for researchers in his study. This could possibly imply that Nigerian researchers are becoming more conscious of linking their researches with the demands of the society and gradually imbibing the culture of conducting researches that could enable them collaborate with industrial firms in resolving industrial problems and to develop new products.

All the researchers claimed they collaborated with other individuals and organisations in one way or the other. The organisations, with which the researchers claimed they collaborated, are indicated in Table 1. The table shows that collaborations of researchers were highest with local research agencies, followed by industrial firms, while the least was with state governments. Though second in terms of intensity, collaborative activities of the researchers with industry were low, as only 29% of the sampled researchers had working relationships with industrial firms.

This result show a slight improvement over that obtained by Oyewale (2005), where about 25% of the researchers had interaction involving information/knowledge exchange with firms in the formal sector of industry. However, if collaborations involving materials/equipment usage are considered, the strength of collaborations had dropped from about 50%. This reduction in collaborations from industry could have resulted from reduced

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capacity utilisation in the firms, which among others was due to constant electrical outages. The Central Bank of Nigeria (CBN, 2009) indicated that the average capacity utilisation in the manufacturing sector reduced from 56.5% in 2003 to 53.84% in 2008.

As expected, among the researchers that collaborated with industrial firms, Faculties of Engineering/Technology had more representation. Though about 30% of the respondents were from the faculty, about 44% of the researchers that had collaborations with industrial firms were from there. In addition, about 38% of the researchers were from Faculties of Science, while the remaining 18% were from Faculties of Agriculture. This shows that researchers from all S&T-based faculties in the universities collaborated with industries.

Table 1: Organisations that Nigerian University Researchers Collaborated with

Stakeholders	% of Researchers
Local Research Agencies	40.8
Industry	29.2
International Research Agencies	17.5
University within Nigeria	6.8
University outside Nigeria	4.9
Local Financial Institutions	2.7
World Bank	2.3
NGOs	2.3
State Government	1.5

Source: NACETEM (2009a)

About 36% of the respondents claimed to have benefited from one support or the other from industrial firms. Responses of the researchers that had such benefits was used to generate Table 2. The table indicates that sponsorship of workshop and conferences and travel fellowships were the most prominent that the multinationals funded. Travel fellowship and staff exchange programmes were more prominent from foreign-owned firms, while indigenous firms sponsorship of workshop and conferences and R&D grants.

The percentages of respondents that received these supports from the different categories of firms were close to those reported by Oyewale (2010), which indicated that about 29% of the researchers claimed they received various kinds of support from industrial firms; with indigenous firms offering the highest support, followed by the multinationals, while foreign-owned firms gave the least. Commenting on why they did not obtain support from the firms, more than 50% of the researchers claimed they did not contact the firms. About 28% of the respondents contacted the firms, but the firms did not respond to their requests, while about 12% claimed their requests were declined.

Table 2:   **Distribution of Types of Support Researchers Received from Industrial Firms**

Type of Support	Multinationals	Foreign owned Firms	Indigenous Firms
Sponsorship of W/shop and Conferences	24.0	17.0	44.0
Travel fellowship	24.0	25.0	13.0
R&D grants	21.0	11.0	31.0
Provision of R&D facilities	18.0	22.0	13.0
Staff Exchange Programmes	6.0	25.0	-
Others	6.0	-	-

Source: NACETEM (2009a)

On the part of industrial firms, they claimed to collaborate with various organisations. Table 3 gives a summary of the organisations, with which the firms claimed they collaborate. The table shows that about 42% of the firms engage the services of Private research institutions, while about 35% engage the services of Public research institutions. These percentages were lower than those reported by Oyewale (2010), where about 60% of the industrial firms claimed they supported various activities of Nigerian institutions. Besides firms' policies, which prevented some from collaborating with the researchers, non-availability of the state-of-the-art facilities that could satisfy the research needs of the firms and inadequate quality of research personnel of the institutions/institutes were indicated by the firms.

Table 3:   **Collaboration of Innovative Firms with Other Actors**

Actors	% innovative firms
Customers	62.9
Associated companies	51.0
Marketing firms	51.0
Private research institutions	42.0
Competitor	40.6
Industry associations	40.6
Supplier	39.9
Financial institutions	37.1
Public research institutions	35.0
Training Institutions	33.6
Higher Education institutions	28.7
Government Ministry	28.7

Source: NACETEM (2009b)

The collaborative activities between Nigerian researchers on the one hand and industrial firms on the other are indications of weak linkages among these elements of Nigerian NIS. In order to address this weakness, the researchers identified the factors that generally impede their individual research endeavours. Their responses were used to generate Table 4. The table indicates that lack of funding, inadequate supply of electricity and lack of R&D facilities were most outstanding among the limitations. These factors could also be responsible for low level of collaborations between the researchers and industry.

Table 4:   Barriers to Tangible R&D of Researchers

Limitation	% researchers
Lack of funding for research	87
Inadequate supply of electricity	82
Lack of R&D facilities	76
Obsolete facilities	67
Lack of exposure to modern lab skills	55
Inadequate water supply	54
Lack of quality research assistance	50
Inadequate access to recent journals/library materials	45
Lack of exposure to conferences	43
Inadequate time for R&D	29
Poor attitude to collaboration among researchers	29
Lack of research drive	24

Source: NACETEM (2009a)

In order to resolve the problem of R&D funding, the Federal Government of Nigeria had put in motion the plan to establish a National Research and Development Fund. When operational, the Fund is expected to finance R&D activities in the country. The problem of the absence of state-of-the-art R&D facilities in the universities is a problem that could also be resolved when the R&D fund takes off. However, because of the high costs of the equipment and in an effort to promote optimal utilisation, central laboratories could be established in institutions that are strategically located, so that researchers in other universities in that neighbourhood can make use of the facilities of the laboratory.

The problem of electricity supply is national, as power generation is far below demand, and power shortage is affecting the whole country. To resolve the issue, the government recently released a Roadmap for Power Sector Reform (FRN, 2010). The Roadmap articulates detailed plan on how to resolve power shortage in Nigeria by involving the private sector in power generation, transmission and distribution.

If the problems identified in this study are resolved, it is very essential for the researchers to improve on their interactions with industrial firms. They need to showcase their abilities to the firms. The government have to come to the aid of these researchers through the establishment of Technology Transfer Offices in the universities where they are not already established.

6. Contributions of the Study

This paper discussed issues affecting industry-knowledge collaborations in Nigeria. It has shows that there is a low level of collaboration between university researchers and industry. The study also shows that, inadequate infrastructure, lack of R&D facilities and poor funding for research are major barriers to research activities in Nigeria. Possible solutions to the problems include improvement of power supply in the country, establishment of central laboratories in some universities and actualisation of the proposed R&D Fund.

7. Policy Implications

This paper discussed issues affecting industry-knowledge collaborations in Nigeria, and it shows that there is a low level of collaboration between university researchers and industry. The policy recommendations that the paper is suggesting are:

i   Government should provide adequate infrastructure especially electricity in the country;

ii   As a start, central laboratories should be established in strategically-located universities;

iii   Nigerian university researchers should conduct more market-driven researches in order to attract industrial collaborations;

iv   Industrial firms should be encouraged to exploit university inventions;

v   Intellectual Property Technology Transfer Offices should be established in the other universities where they have not been established.

References

Bamiro, O. A.; Mikailu, A.S.; Obiaga,T. and Nyagba, S. (2008) Review of Nigeria's Science, Technology and Innovation System. Nigeria/UNESCO Project. Consolidated Draft Report.

Branscomb, L.M. (1997) From technology politics to technology policy, *Issues in Science and Technology Online,* Spring 1997.

Bremer, H. W. (2001) The First Two Decades of the Bayh-Dole Act As Public Policy, Presentation to National Association of State Universities and Land Grant Colleges, Washington, D.C. November 11, 2001. Obtained from: http://www.nasulgc.org/COTT/Bayh-Dohl/Bremer_speech.htm

CBN (Central Bank of Nigeria) (2009) Statistical Bulletin 2009, Part C – Real Sector Surveys, Table C.4 Manufacturing Capacity Utilisation, Accessed September 10, 2010. Available at: http://www.centralbankofnigeria.gov.ng/OUT/2010/PUBLICATIONS/STATISTICALBULLETINS/2009/PartC/TableC.4.1.xls

CSP (Council for Scientific Policy) (1967) *Second Report on Science Policy*, HMSO, London, Cmnd, 3420, Paragraph 45.

Dzisah J. and Etzkowitz H. (2009) Triple Helix Circulation: The Heart of Innovation and Development, Triple Helix VII Theme Paper, Triple Helix Group, Newcastle University Business School. Accessed on September 10, 2010, Available at: http://www.triple-helix-7.org/Triple%20Helix%20VII-Theme%20Paper.pdf

Freeman, C. (1987): Technology Policy and Economic Performance: Lessons from Japan. London Pinter Publishers

FRN (Federal Republic of Nigeria) (2010) Roadmap for Power Sector Reform, (A Customer-Driven Sector-Wide Plan To achieve stable power supply) Accessed September 10, 2010. Available at: http://www.nigeriapowerreform.org/downloads/Roadmap%20for%20Power%20Sector%20Reform%20Full%20Version.pdf

Hagedoorn, J., (1993) Understanding the Rationale of Strategic Technology Partnering: Interorganizational Modes of Cooperation and Sectoral Differences. *Strategic Management Journal* 15(5), pp. 371-385

MAN (Manufacturers Association of Nigeria) (1994) Nigerian Industrial Directory, Manufacturers Association of Nigeria, Lagos.

Meyer-Stamer, J. (1995) New departures for technology policy in Brazil, *Science and Public Policy*, October, 1995, pp. 295-304.

NACETEM (2009a). Assessment of R&D Productivity in Nigerian Universities and Research Institutes

--------- (2009b). Assessment of Innovation Capability in the Manufacturing Sector in Nigeria

NBTE (National Board for Technical Education) (2009) Approved Federal Polytechnics in Nigeria, Accessed 22/12/09, Available at: http://www.nbte.gov.ng/institutions.html

NUC (National University Commission) (2009) List of Nigerian Universities and Years Founded, Accessed 22/12/09, Available at: **http://www.nuc.edu.ng/pages/universities.asp?ty=1&order=inst_name**

Numprasertchai, S., and Igel, B., (2005) Managing Knowledge through Collaboration: Multiple Case Studies of Managing Research in University Laboratories in Thailand. *Technovation* 25 (10) (2005) pp. 1173-1182.

OECD (Organisation for Economic Co-operation and Development) (1998) *Science, Technology and Industry Outlook, 1998*, OECD, Paris.

-------- (2002). Frascati Manual: Proposed Standard Practice For Surveys On Research And Experimental Development. OECD, Paris.

Ogada, T. (2009). Generation, Protection and Commercialisation of IP Assets

Oyewale, A. A. (2005) Addressing the Research-Industry Linkage Impasse in Nigeria: the Critical Issues and Implementation Strategies'. Paper presented at the Third International Globelics Conference – Africa 2005, Orgainised by the Global Network for the Economics of Learning, Innovation and Competence (Globelics) held at the Tshwane University of Technology, Tshwane, South Africa between October 31 and November 4, 2005.

-------- (2010) The Nigerian National Innovation System: Issues on Interactions of the Key Elements. A Monograph of the National Centre for Technology Management, Obafemi Awolowo University, Ile-Ife (forthcoming).

Rothschild, V. (1971) The organisation and management of government R&D, in *A Framework for Government Research and Development*, HMSO, London, Cmnd, 4814.

Taylor, J.B. (1994) 'Discovery of new medicines', In: Griffin, J.P., O'Grady, J. and Wells, F.O. (Eds.) *The Textbook of Pharmaceutical Medicine*, 2nd Edition, Greystone Books, Antrim, N. Ireland.

The World Bank (2007) How Universities Promote Economic Growth. The International Bank for Reconstruction and Development. Washington, USA.

Tiffin, S. (1997) Building Science and Technology Innovation Systems in Africa, Paper delivered at the First Regional Workshop on The Restructuring of National Science and Technology Systems in Africa, Regional Programme for Technology Management (REPTEM), Lagos, May 12-16, 1997.

UNESCO (United Nations Educational, Scientific and Cultural Organisation) (1979) *An Introduction to Policy Analysis in Science and Technology*, ISBN 92-3-101725-X.