



Emergent Model for Accelerating University-Industry Collaborations and Enhancing Innovation among Universities in Nigeria

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ABSTRACT

The prime role of universities is to provide effective solutions to the development challenges of their societies by serving as generators of ultramodern scientific knowledge. Majority of the contemporary developed countries possess pinnacle research universities. Universities and Industries Collaborations (UIC) has proven to be one of the formidable ways to effectively provide such support. The process requires government participation to facilitate the creation of knowledge which ultimately generate innovation and also propel the process of socio-economic improvements. Scholars have, over the years, built strong argument around the triple-helix model to ascertain that the process of the collaborations and innovation generation becomes robust when government is involved. However, some recent studies have proposed new models that have incorporated additional elements hence suggesting that, the process would be better enhanced when other elements are added to the original model. Arising from review of the findings in previous studies and other related models, this study adopted the methodology of collecting primary data from respondents across universities in Nigeria on constraints inhibiting sustained and robust UIC, intensity of UIC, intensity of Innovativeness as well as strategies used for accelerating UIC and Innovation among Universities in Nigeria. Arising from the analyses of the data and synthesis of the previous models, the study proposes an enhanced model that incorporates universities to engage in a broad range of companies rather than a few in research activities, pursue global corporate-sponsored research opportunities, establish clear framework of IPRs agreement prior to commencement of collaboration with industries, engage industry experts in university research and innovation activities, seek guidance on the technologies and techniques required for practical application of knowledge beneficial to the society, as well as adopt inventive methods to integrating new technology associated skills in the curriculum as additional critical elements capable of accelerating innovativeness of universities in Nigeria.

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INTRODUCTION

University-industry collaboration (UIC) signifies a dynamic association among universities and industries which drives innovation, nurture economic growth, and provides solutions to societal developmental

matters [1]. Nigeria has over the years demonstrated its aspiration for the advancement of the country's frontiers of science, technology and innovation agenda as a critical vehicle for attainment of the sustainable development goal as

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well as becoming a fully developed nation among other countries of the world.

Within the context of national development, universities are usually regarded as essential vehicles to the development of knowledge and innovation through the primary role of training, conduct of basic and applied research in the fields of science, technology, engineering and mathematics as well as engaging in community development services. Universities represent the critical instruments of national economic development and innovation [2].

Along the side this, firms in the industry are expected to gain opportunities for specific access to highly trained human resources, new products and process ideas, highly standardised research facilities in the universities as well as provide funding opportunities to universities. Similarly, in a complementary manner, the Federal government is expected to perform important role of coordinating and consolidating the relationships and activities of the firms and universities targeted at promoting innovation in the country [3]. The attainment of the objectives of these three distinct roles could only be achieved through effective collaborative arrangement between the universities, the industries and government as explained in the traditional model of the UIC [4].

The traditional pattern of the collaboration was built on the triple helix model which explains the connexion between universities, industry, and government in promoting and sustaining research, innovation and knowledge that promote the science, technology and innovation (STI) goals of countries. All the three actors are expected to engage in a dynamic exchange that creates an environment of creativity and innovation. It explains that universities' research groups, businesses and government agencies are formed to interact in a dynamic relationship. The emphasis in this model is that government is the main driver of the dynamic interaction [5]. However, further contributions were made to expand argument which gave birth to new perspective in which the actors were segregated with distinct roles under the presumption that university is the principal driver in creating and sustaining dynamic synergy in the exchange model. Figure 1 depicts the performances scores of different countries in terms of research collaborations between the years 2018-2022, which shows Nigeria as a low level performer.

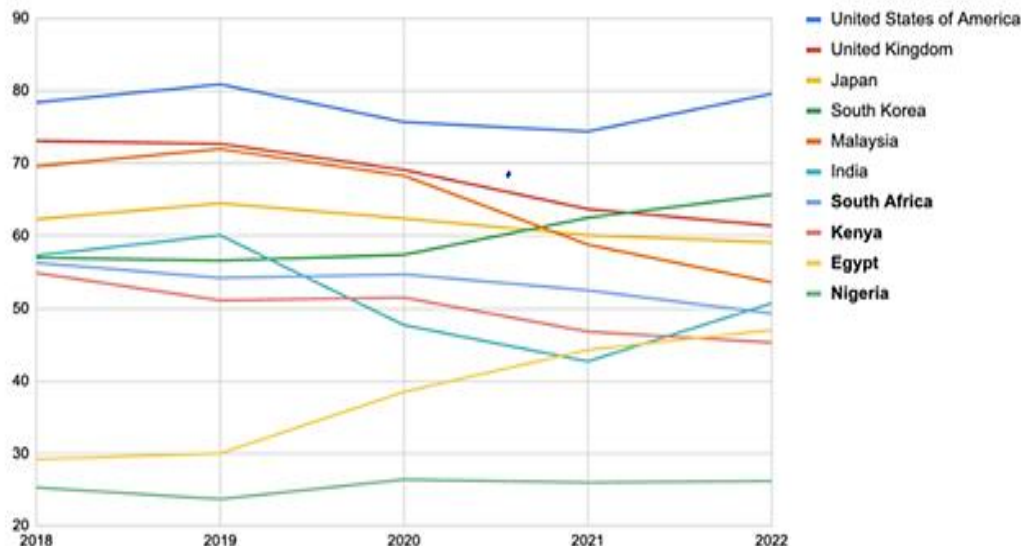


Figure1: University-Industry Research Collaborations Score from 2018-2022

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This study aims at building on the new perspective on UIC and innovation in universities by exploring the current dynamics in the relationship and developing a model for acceleration of the UIC and enhancing innovation in the Nigerian university context. In order to achieve the main objective, the specific objectives were set as follows:

- i. to assess the existing UIC Models adopted in different context around the world and the potential gaps.
- ii. to evaluate the existing state of UIC and innovativeness amongst universities in Nigeria.
- iii. to propose a comprehensive UIC models for innovativeness based Nigerian data.

The current study is organised as follows: Section 1 provided introduction of the study. Section 2 contained the significance of the study, section 3 covered the review of the related literature. Section 4 discussed the methodology adopted for the study. Section 5 presented the results based on the adopted methodology. Section 6 discussed the emergent model for accelerating the UIC in Nigeria. Section 7 presents discussion and implication of the study. Section 8 highlighted the significance of the study. Finally, section 9 concludes the findings of the study.

Significance of the Study

The significance of this study cannot be overemphasized, especially given its focus on UIC and its essential role in driving innovation within the realm of Nigerian Universities. By concentrating on UIC, the research addresses some key gaps inherent in the innovation ecosystem of Nigeria, where the relationship between academic research and practical application in the industry seems to be frail historically. From the foregoing, this study significance includes:

1. *Emergent Model Development:* this research presents Nigeria's innovation issues within the global context with a focus on widely discussed triple helix model and other related frameworks. It recognizes inhibitors like inadequate

infrastructure, intellectual property disputes, and weak access to information that impedes effective UICs in Nigeria. A tailored framework was proposed which offers a robust way to address these issues while aligning with global best practices.

2. *Relevance to National Development Policies:* the explicit prioritization of science, technology and innovation by the Nigerian government as an enabler of economic growth is eminent. Hence, this study outlined a practical blueprint for policy makers and practitioners by emphasizing the need for strong frameworks, sustainable funding mechanism, and other linkage institutions like technology transfer offices. This highlights the government role in providing an enabling environment, bringing a timely contribution to policy deliberation on STI.
3. *Improving Innovativeness in Universities:* universities have historically been the hub for building both human capital, skilled manpower, and knowledge dissemination. This research beyond theoretical contribution, has looked in-depth in to the prevailing and sub-optimal condition of UIC within the Nigerian higher education institutions. A condition characterized by limited research funding, weak R&D outputs, limited commercialization activities, and low patenting of scholarly works. Proposing an enhanced model emphasizes the need for active UIC between the academia and industries, and outlined a blueprint for universities to be proactive in innovation.
4. *Bridging the UIC Gap:* the study outlined numerous advantages generated from UIC, ranging from access to up-to-date research for industries, to global sustainable funding to universities. The research suggested a robust



collaboration with diverse industries, pursuance of world class research opportunities, improvement in university curricula to align with global practice, and ensuring a good synergy that triggers innovation within the ecosystem.

LITERATURE REVIEW

Concept of University-Industry Collaboration

University-industry collaboration (UIC) refers to the partnership between different segments of the higher education system and the industry. The main goal here is to promote the sharing of knowledge and technology, which ultimately helps to boost the knowledge base of organizations [6]. This is primarily conducted to spark innovation, share knowledge, and create benefits for everyone involved. In today's fast-paced economy, where technology is continuously evolving at lightning speed and competition is fierce, these collaborations are more crucial than ever, as it assists to blend academic research with practical applications in the industry. Being a crucial part of innovation ecosystems, UIC provides a good connection between theoretical research and solution to real-world issues. This relationship is built on a shared commitment to promote common goals, primarily by fostering knowledge through research and exchanging of technology to advance their mutual interest [7].

According to Organization for Economic Cooperation and Development OECD [8], universities have been crucial in generating new knowledge and training the skilled workers that knowledge-based economies rely on. The industries served as both recipients of the knowledge and technology, including the environments where the technology and knowledge is put into practice [9]. UIC is also viewed as the driving force behind [10, 11] knowledge [9, 12], the industry is regarded as the entity that transforms research and innovation into practical products and services [13].

The literature points to many diverse types of UICs, such variations depend on their approach, the length of the partnership, the objectives and expected outcomes perceived by

both parties [10, 11]. However, the most frequently forms discussed in the literature as cited in Ankrah and Omar [10] and Rossoni, et al. [6], are: knowledge transfer in form of product development and commercialization activities, academic consulting, research funding (e.g., endowment and trust fund), collaborative research and development activities, exchange of resources and expertise, joint authorship of journals and books, joint symposia, consulting relationship, sabbaticals in industries and action research, employment of graduates by the industry, training of industry members, licensing of university patents by the industry, purchase of prototype developed by the university, informal meetings, conversations and communications, and numerous other interactions not outlined.

Similarly, it has also been established that both the industry and the academia mutually benefit from the collaboration activities through transfer of knowledge, expertise or technology including the application of research findings in solving practical problems, scientific questions and or the creation of several scholarly opportunities [14]. Such partnerships become a major facilitator of innovation and economic growth as it allows universities to take advantage of their resources and expertise to solve practical problems and to develop new technologies, thereby giving businesses access to emerging research and development capabilities. In addition, both parties benefit on personal level as research enables the industry to gain new perspectives, learn about new and emerging technologies, have access to diverse facilities and equipment, and develop critical competencies. Whereas, the academia has the ability to publish more and create patents, spin-off companies to commercialize their research results and scholars are also motivated by a desire to contribute to national development, job and wealth creation and more.

Government Policies on UIC

Conventionally, the provision of education and production of graduates to meet the global need of industry and public workforce has been the major role of universities. Collaboration



between academia and industry is increasingly a similar critical component of efficient national innovation systems. It is very pertinent to note that in making UICs a reality, government plays a very crucial role in fostering UIC via the creation of an enabling environment, reliable funding mechanisms, research and development projects, innovation, economic growth, regulatory reforms, grants and institutional growth [15]. Moreover, part of policy role of government is the provision of essential infrastructure and intermediary institutions like technology transfer offices (TTOs), technology parks, innovation hubs and business incubators to boost collaboration. Similarly, governments can also encourage collaboration through more subtle mechanisms such as offering targeted support services to businesses and universities as they look for partners, including engagement in outreach activities to foster networking and highlight the significance of working together [16].

Several governments and multinational regulatory institutions around the globe have proposed and established diverse contextual policy frameworks and initiatives with the aim to encourage and boost UICs [17-19]. For example, OECD [2] developed a policy instrument which examined numerous policy documents to boost and support science-industry knowledge transfer implemented across countries globally to foster effective collaboration, and more recently, the Creating Helpful Incentives to Produce Semiconductors (CHIPS) and Science Act, 2022, allocated several billions of dollars to strengthen R&D collaboration between universities and industries [20]. Moreover, government also provide funding support in form of grants, tax credits, and subsidies in certain areas to boost R&D projects; it also create policies regarding intellectual property (IP) to provide ownership, equitable benefit sharing, and commercialization rights of innovation to foster and strengthen trust between universities and industries; establish innovation hubs and build science parks to co-locate universities and industries, enable and enhance exchange of knowledge and provide enormous collaborative opportunities and many more.

In Africa, such initiatives and policy reforms are also developed contextually to promote UICs as part of different national development agendas. For instance, the South Africa's Technology Innovation Agency (TIA), which facilitates the funding of R&D projects with commercial viability, and the Department of Science and innovation (DSI) which encourages linked research chairs in universities [21]. Similarly, numerous scholars also emphasized the need for a strong collaboration between universities, industries, and government agencies to encourage and boost innovation and knowledge transfer [22]. A study by Bastos, et al. [16] also revealed that over the past 50 years, government policies and initiatives have played a key role in the growth of UICs around the world.

In Nigeria several policy initiatives and reform programs have been made with regards to UICs to encourage collaboration between universities and industries. This policies and programs include among others, the establishment of Tertiary Education Trust Fund (TETFund) with the aim of providing qualitative education, training programs, research grants, providing infrastructural facilities, as well as proving support to industry related research projects to tertiary institutions in the country. This is done to strengthen and encourage the collaboration between industry and the universities with the aim of driving technological development [23]. Others include the establishment of Industrial Training Fund (ITF) to place students on industrial training for hand-on experience from the industries, the national science technology and innovation policy aim at promoting technology transfer offices in the universities as well as the 1986 national science and technology policy which was established to encourage R&D projects and the translation of research results in to viable commercial products.

Historical Development Process of UIC Models

The emergence of UIC models dates back to the late 19th century, in the US, where collaborations began especially in Agriculture, it was majorly between land-grant universities and local industries. Though, the process was highly

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informal, with a focus on consultancy services where educational institutions enlightened farmers and engaged students to gain practical knowledge in the field. The relationship relies on local funding from the government through decentralization of the higher education institutions which encouraged the universities to solve the regional needs of the industry. Research collaboration began in the beginning of the 20th century, in the field of sciences and engineering motivated by mutual interest and quest to solving problems. According to [24], early technology transfer (TT) was introduced in 1912, by the Research Corporation. Despite its scope limitations, however, proceeds managed from the university patent were used to fund scientific research.

By the late 1920's through 1930's, more structured UIC models emerged with intense collaboration. There were great advancements in chemical engineering as a result of collaborations further anchored by resource sharing. Numerous educational partnerships were also formed, Research Corporation extended its TT role by increasing its patent management to more universities. Europe witnessed less growth of UIC models but witnessed early research collaboration in physical sciences which created a stage for future progress [24].

Numerous policy measures were brought at the end of the 20th century to strengthen university-industry partnership. Part of such policies is the 1980 Framework Programmes in Europe (supporting collaboration and resource sharing), and the Bayh-Dole Act of 1980 (US) which warrants the retention of intellectual property rights by the universities for researches funded by the federal government. This later encouraged the commercialization of research findings and discoveries. More so, the conceptualization of the dynamic interaction between the universities, industries and government also emerged through the formulation of the Tripple Helix Model [25]. Similarly, other

initiatives in Europe such as the Lisbon Strategy (2005-2010) and the University-Business Forum (2008-present), promoted all models, especially those related to educational collaborations and students engagement, to agree with the current industry requirement [26].

The 21st century witnessed a diverse and interconnected models in form and scope driven by the need for innovation in a digital era. Several models emerged like the public-private partnerships, open innovation platforms, research consortia, student engagement, educational collaborations, and the triple helix collaborations which is actively shaping global ecosystems among others. Although this came with a lot of challenges like differences in culture between the universities and the academia, issues related to intellectual property rights, and research integrity were outlined. Such issues require robust framework that resolves the inhibitors and drivers to successful partnership.

Models of UIC

These represent the systematic way of establishing and managing the collaboration between academic institutions and industrial firms for mutual benefit, such as knowledge transfer, innovation, and economic development. There are various models developed to structure, guide and improve the collaboration process between the university and industry, each of these models are shaped by the nature of the partnership, the level of engagement, and the desired outcomes. Some of the most prominent UIC models are as follows: *The Triple Helix Model*: This Model highlights how universities, industries, and governments work together to drive innovation and economic development. This approach shows that when the three different groups collaborate, they can create new knowledge, technologies, and boost economic growth. Over time, the model, as shown in figure 2, has adapted to include hybrid organizations, like technology transfer offices and science parks, which make these collaborations materialize [27].

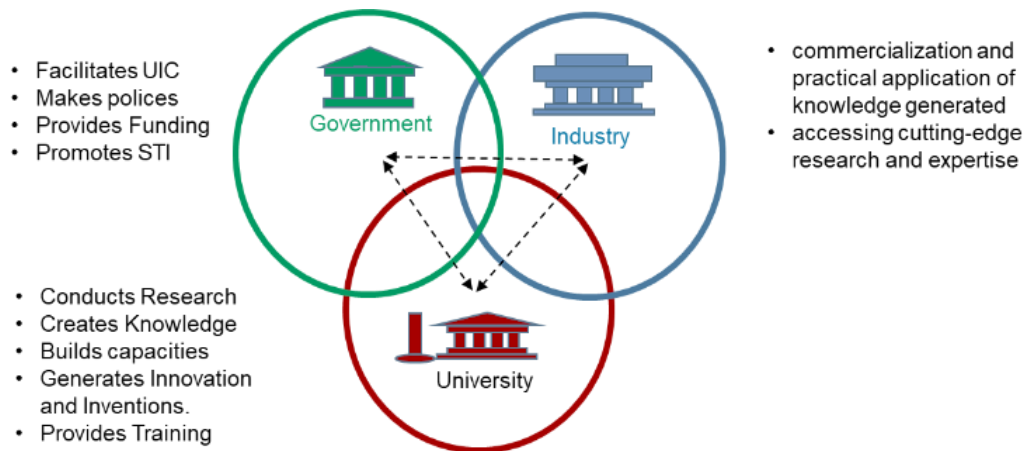


Figure 2: Triple Helix Model Conceptualizing UIC

The Network Model:

This model emphasizes the importance of networks and relationships in enabling university–industry interactions. The model proposes that the collaboration should be based on trust, communication, mutual understanding, and shared goals among others. It also emphasizes the importance of intermediaries like technology transfer offices, research centers and others in bridging the gap between universities and industries [28].

The Evolutionary model:

This model emphasizes on the dynamic and complex nature of university–industry interactions. It proposes that the collaboration changes over time through distinct stages, such as embryonic, initiation, engagement, and established stage. The model also pinpoints the obstacles and facilitators in each phase, including factors such as trust, intellectual property, and teamwork [28, 29].

Collaborative Model:

This involves the establishment of dedicated research centres (hubs) where universities and industries share resources, funding, expertise, decision making and risks to collaborate on long-term strategic joint research project. Such collaboration fosters deeper engagement and knowledge exchange between academia and the industry.

Technology Transfer Model (Entrepreneurial Universities):

In this model, technologies, innovations, and research outputs such as software, prototypes developed by the university community are transferred to marketable products for commercialization through patents, licensing, or spin-off companies. This model enables industries to commercialize recent innovations that emanate from the academia, and the industries benefit from royalties or revenue-sharing arrangements. With this setup, universities take on the role of active economic players, helping to drive both regional and national development [30].

Open Innovation Model:

This model establishes that the university and industry share knowledge, organizational resources, ideas and expertise across their boundaries via the use of digital tools and crowdsourcing to solve complex issues. Contrasting the traditional technique, it encourages external collaboration through divergent views. As a key feature, the model puts more emphasis on knowledge sharing, co-creation, and involvement of multiple stakeholders to solve complex global issues [31].

Other models also exist based on literature [10, 32] however, the choice of a model depends on the goals set out to achieve. These different models of UIC indicates the diversity and complexity of partnership between the academia and industry which in the end fosters innovation,

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knowledge transfer and economic growth. Each of these different models has its strength and challenges depending on the context and the objectives set out. They all indicate the importance of aligning academia and industry goals to drive innovation and provide solution to complex societal problems.

METHODOLOGY

A descriptive research design is adopted in this study for evaluating the existing state of UICs and the innovativeness of the universities in Nigeria. This technique allows a quick and clear summarization and interpretation of patterns and relationships among the variables in the study. A well-structured survey questionnaire was administered to the relevant stakeholders within the university and industry. Diverse views of respondents were captured on the nature, extent, and effect of UICs including the perceived drivers and inhibitors of innovation within the academia.

Academic and non-academic staff across the various universities in Nigeria formed the target population. We employed a purposive sampling technique for adequate inclusion of respondents with first-hand knowledge and experience of university-industry engagement. Closed-ended questionnaire was designed based on Five Likert-Scale to collect data from respondents. The analysis was conducted and presented using descriptive statistical technique such as frequencies, percentages, mean, standard deviation, tables, bar charts, and histogram with the aid of the Statistical Package for the Social Sciences (SPSS) version 25 and Microsoft Office Excel 2016.

Descriptive Statistics

This sub-heading has discussed the descriptive statistics on the key study variables based on frequency, percentile, mean and standard deviation.

Respondent Institutions' Information

As shown in Fig. 3, the Institutional information in terms geographical 'location', revealed that majority responses came from north-

east with 30%, north-central with 27.86%, north-west with 21.43%, south-west with 8.57%, then south-south with 6.43% and lastly south-east with 5.71%.

Respondent Institutions' Information

Define abbreviations and acronyms the first time they are used in the text, even after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, sc, dc, and rms do not have to be defined. Do not use abbreviations in the title or heads unless they are unavoidable.

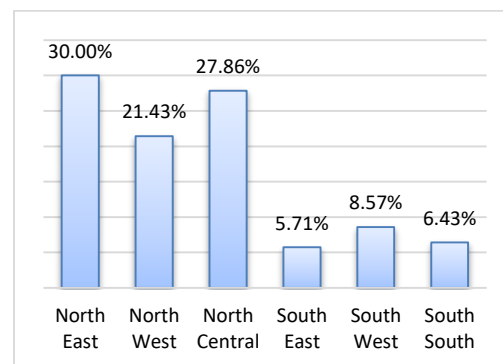


Figure 3: University Location

University status variable indicated the institutions of the respondents. From fig. 4, Federal Universities has the highest respondents which constitute 66% responses. State Universities as the second status has 33% of the respondents, then followed by Private University which constituted only 1% of the respondents.

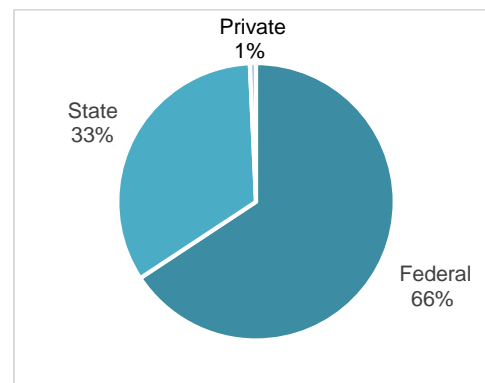


Figure 4: University Status

Analyses of Data

Table 1, 2, 3 and 4 presented descriptive statistics items using frequencies, percentiles, mean scores and standard deviations of the study variables.

Constraints Inhibiting Sustained Robust UIC

In spite of concerted efforts by universities in Nigeria to enhance their institutional capacity for collaboration with industry, they are confronted with constraining challenges principally occasioned by operational environmental imperfections. The analysis of the data revealed the following behaviour of the responses as shown in Table 1 which presents the extent of the effect of constraints which inhibit sustaining robust UIC. From the first item "Intellectual property (IP) rights regimes" 57(15.5%) respondents stated that their area of thrust is covered by either copyright, patent or trademark protection. This was followed by low and high with frequency and percentile of 36(9.8%) and 28(7.6%) respectively. Very high and none intellectual property regime was opted by 3(0.8%) and 16(4.4%) respondents. The mean and standard deviation for IP regime is 2.76 and 0.974 respectively.

On the aspect of 'difficulties in negotiating a collaboration' was reported as moderate, high, low by 61(16.6%) 32(8.7%) and 29(7.9%) respectively. While, 9(2.5%) respondents reported a very high and none

difficulties in negotiating a collaboration in their area of thrust. The mean of 3.02 and standard deviation 0.978 was revealed from the data analysis. Consequently, 55(10.4%), 38(10.4%) and 32(8.7%) of the respondents indicated that 'weak access to information results in difficulties of finding contact persons' is moderate, high and low respectively, in their institutions. The ratings were followed by 8(2.2%) and 7(1.9%) respondents who opted for none and very high respectively. The mean and standard deviation for this item was reported as 3.15 and 0.981 respectively.

Furthermore, the result revealed that 48(13.1%), 38(10.4%), 25(6.8%), 20(5.4%) and 9(2.5%) reported level of motivation and entrepreneurial spirit among faculty' are high, moderate, low, very high and none, respectively. This was also defined by the mean and standard deviation of 3.32 and 1.121 respectively. Finally, the result of this study revealed that 43(11.7%), 42(11.4%), 28(7.6%), 21(5.7%) and 6(1.6%) respondents indicated that 'inadequate infrastructure' is moderate, high, very high, low and none respectively. The total responses were explained by a mean and standard deviation of 3.46 and 1.102 respectively. The total of all the respondents' ratings for 'none', 'low', 'moderate', 'high', and 'very high', 'mean' and 'standard deviation' are 58(6.90%), 162 (19.29%), 314(37.38%), 230(27.38%), 76(9.05%), 3.12 and 1.02 respectively.

TABLE 1: DESCRIPTIVE STATISTICS ON IMPEDIMENTS TO ROBUST UIC SUSTAINABILITY

| Items | None | Low | Moderate | High | Very High | Mean | Std. Dev. | N |
|--|----------|----------|-----------|-----------|-----------|------|-----------|-----|
| 1. Clarity of Intellectual property (IP) rights regimes. | 16(4.4%) | 36(9.8%) | 57(15.5%) | 28(7.6%) | 3(0.8%) | 2.76 | 0.974 | 140 |
| 2. Difficulties in negotiating a collaboration. | 9(2.5%) | 29(7.9%) | 61(16.6%) | 32(8.7%) | 9(2.5%) | 3.02 | 0.978 | 140 |
| 3. Weak access to information results in difficulties of finding contact persons | 8(2.2%) | 32(8.7%) | 55(15%) | 38(10.4%) | 7(1.9%) | 3.03 | 0.967 | 140 |

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| Items | None | Low | Moderate | High | Very High | Mean | Std. Dev. | N |
|---|------------------|---------------------|--------------------|--------------------|------------------|-------------|-------------|-----|
| 4. Transaction costs of finding the right partner | 10(2.7%) | 19(5.2%) | 60(16.3%) | 42(11.4%) | 9(2.5%) | 3.15 | 0.981 | 140 |
| 5. level of motivation and entrepreneurial spirit among faculty | 9(2.5%) | 25(6.8%) | 38(10.4%) | 48(13.1%) | 20(5.4%) | 3.32 | 1.121 | 140 |
| 6. Inadequate infrastructure | 6(1.6%) | 21(5.7%) | 43(11.7%) | 42(11.4%) | 28(7.6%) | 3.46 | 1.102 | 140 |
| Grand Total | 58(6.90%) | 162 (19.29%) | 314(37.38%) | 230(27.38%) | 76(9.05%) | 3.12 | 1.02 | |

Intensity of UIC amongst Nigerian Universities

Table 2 revealed the results of the Intensity of UIC amongst Nigerian Universities. The first item results on the 'number of Collaborative R&D with industries recorded by the department or unit' revealed that the following options were selected by the respondents: low = 64(17.4%), moderate = 34(9.3%), none = 32(8.7%), high = 9(2.5%) and very high = 1(0.3%), with the mean = 2.16 and standard deviation = 0.878. The result of 'integration in industry related innovation activities indicated that: low = 71(19.3%), moderate = 33(9.0%), none = 27(7.4%) and high = 9(2.5%), while very high obtained no response. The mean and standard deviation are 2.17 and 0.813 respectively. Similarly, the result showed that; 'research-related activities commissioned in your university' obtained responses from respondents in the following hierarchy; moderate = 70(19.1%), low = 43(11.7%), high = 16(4.4%), none = 8(2.2%) and very high = 3(0.8%).

The mean and standard deviation for the total responses on this item is: 2.74 and 0.819 respectively. Additionally, the item of 'industrial client services provided by your university' gained responses and respondents as; low = 62(16.9%), moderate = 53(14.4%), none = 14(3.8%), high = 10(2.7%) and very high = 1(0.3%), with equivalent mean score and standard deviation of 2.44 and 0.798 respectively. With respect to 'intensity of consulting services offered to industry, the responses revealed the following frequencies and

percentiles: low = 69(18.8%), moderate = 50(13.6%), none = 11(3.0%) and high = 10(2.7%), while none = 0. The mean and the standard deviation are obtained as 2.42 and 0.74 respectively. The 'level of quality control and certification services offered to firms' responses are: low = 69(18.8%), moderate = 45(12.3%), none = 13(3.4%), high = 12(3.3%) and very high = 1(0.3%), while the mean and standard deviations are 2.42 and 0.805 respectively.

In the item, 'extent of use of your university-based labs & equipment by firms', the responses are: low = 66(18.0%), moderate 38(10.4%), none = 20(5.4%), high = 16(4.4%) while very high obtained no response. The mean and standard deviation are 2.36 and 0.866. Similarly, from the item 'engagement with business incubators in innovative research', have responses like these: low = 61(16.6%), moderate = 42(11.4%), none = 29(7.9%), high = 8(2.2%) while very high has no response. And the mean and standard deviation are 2.21 and 0.835. Then from 'level participation in technology parks activities', the responses are: low = 65(17.7%), moderate = 42(11.4%), none = 18(4.9%), high = 14(3.8%) and very high = 1(0.3%). The mean and standard deviation are: 2.39 and 0.862 respectively. Moreover, Industry co-funding of your university innovation activities item's responses is: low = 70(19.1%), moderate = 42(11.4%), none = 24(6.5%), high = 4(1.1%), however no response was obtained from very high.

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The mean and standard deviation are 2.19 and 0.745. Never the less, the item 'level of commercialization of inventions has the following responses: low = 77(21.0%), moderate = 29(7.9%), none = 25(6.8%), high = 9(2.5%) and zero response to very high. However, the mean and standard deviation are 2.16 and 0.789. The next item, 'Commercialization of innovative ideas of start-ups or spin-offs' revealed the following responses: low = 75(20.4%), moderate = 32(8.7%), none = 31(8.4%), high = 2(0.5%) but no response was gotten from very high. Then the mean and standard deviation are 2.04 and 0.714. Another item is 'transfer of university-generated intellectual property rights to industry' which has responses as; low = 71(19.3%), none = 35(9.5%), moderate = 30(8.2%), high = 4(1.1%) without any response from very high. The mean and standard deviation are 2.02 and 0.763. The licensing of products and process patent/copyrights to firms' item has responses as; low = 73(19.9%), none = 35(9.5%), moderate = 26(7.1%), high = 6(1.6%) with zero response to very high, whereas the mean is 2.02 and the standard deviation is 0.782. From the next item, 'rate of secondments/sabbatical of university staff to industry', the responses are: low = 76(20.7%), moderate = 34(9.3%), none = 21(5.7%), high = 8(2.2%) and 1(0.3%) to very high, with 2.23 and 0.799 as mean and standard deviation.

Also, the item, 'rate of staff participation internship programs to industries' with low = 81(22.1%), moderate = 24(6.5%), none = 21(5.7%), high = 14(3.8%) while no response was obtained from very high. The mean and standard deviation are 2.22 and 0.823. Another item is 'rate of adjunct faculty in industry participants', with the following responses; low = 84(22.9%), moderate = 29(7.9%), none = 24(6.5%), high = 3(0.8%) and zero response to very high, with the mean and standard deviation as 2.08 and 0.679 respectively. Consequently, the item 'rate of undergraduate industry experience training' revealed response of moderate with 63 (17.2%), low with 40(10.9%), high with 31(8.4%), very high with 4(1.1%) and none with 2(0.5%), whereas, 2.96 and 0.826 are the mean and standard deviation.

The item 'rate of postgraduate internship training' revealed the responses of low with 64(17.4%), moderate with 48(13.1%), none with 22(6.0%), high with 6(1.6%) while very high with no response. The mean and standard deviation revealed 2.27 and 0.776 respectively. From the item 'Intensity of organizing and attending conferences/public lectures/seminars' the result revealed the responses of moderate = 70(19.1%), low = 44(12.0%), high = 22(6.0%), very high = 3(0.8%), none = 1(0.3%) with the mean = 2.87 and standard deviation = 0.757. The next item states 'Commitment to developing networks through organized social events' obtained results of moderate, low, high, very high and none from 70(19.1%), 56(15.3%), 12(3.3%), 1(0.3%) and 1(0.3%) respondent correspondingly. With the mean of 2.69 and standard deviation of 0.669.

Moreover, from the item which state 'organizing and attending exhibitions and tradeshow' the responses are: low = 71(19.3%), moderate = 46(12.5%), high = 13(3.5%), none = 10(2.7%) and no response obtained from very high, while the mean and standard deviation of the item are 2.44 and 0.761. The next item 'building of relationships through attending anniversary events' revealed the following responses low = 54(14.7%), moderate = 60(16.3%), high = 17(4.6%), none = 9(2.5%) and option 'very high' with no response.

The result revealed the mean and standard deviation with 2.61 and 0.784 respectively. The next item is 'intensity of postgraduate training of your university staff' has 60(16.3%), 41(11.2%), 26(7.1%), 10(2.7%), 3(0.8%) who correspond the choices of moderate, low, high, none and very high respectively. However, the mean score and the standard deviation revealed 2.79 and 0.902. More so, from the item 'access to R&D incentives and grants in your university' the responses are moderate = 61(16.6%), low = 57(15.5%), none = 12(3.3%), high = 10(2.7%) and no response obtained from option 'very high' while the mean and standard deviation are 2.49 and 0.754. from the last item which states 'availability of appropriate reward systems for researchers' has the following



responses low = 79(21.5%), moderate = 31(8.4%), none = 20(5.4%), high = 10(2.7%) and no response from 'very high'. The mean scored 2.22 with standard deviation 0.778.

However, the grand total for these items as none, low, moderate, high and very high is

475(13.05%), 1683(46.24%), 1162(31.92%), 301(8.27%) and 19(0.52%) whereas the total scores of the mean and standard deviations of the items are 2.37 and 0.79.

Table 2: Descriptive Statistics of the Intensity of UIC

| Items | None | Low | Moderate | High | Very High | Mean | Std. Dev. | N |
|---|----------|-----------|-----------|----------|-----------|------|-----------|-----|
| 1. Number of Collaborative R&D with industries recorded by the department or unit | 32(8.7%) | 64(17.4%) | 34(9.3%) | 9(2.5%) | 1(0.3%) | 2.16 | 0.878 | 140 |
| 2. Integration in industry related innovation activities | 27(7.4%) | 71(19.3%) | 33(9.0%) | 9(2.5%) | 0 | 2.17 | 0.813 | 140 |
| 3. Research-related activities commissioned in your university | 8(2.2%) | 43(11.7%) | 70(19.1%) | 16(4.4%) | 3(0.8%) | 2.74 | 0.819 | 140 |
| 4. Industrial client services provided by your university | 14(3.8%) | 62(16.9%) | 53(14.4%) | 10(2.7%) | 1(0.3%) | 2.44 | 0.798 | 140 |
| 5. Intensity of consulting services offered to industry | 11(3.0%) | 69(18.8%) | 50(13.6%) | 10(2.7%) | 0 | 2.42 | 0.740 | 140 |
| 6. Level of quality control and certification services offered to firms | 13(3.4%) | 69(18.8%) | 45(12.3%) | 12(3.3%) | 1(0.3%) | 2.42 | 0.805 | 140 |
| 7. Extent of use of your university-based labs & equipment by firms | 20(5.4%) | 66(18.0%) | 38(10.4%) | 16(4.4%) | 0 | 2.36 | 0.866 | 140 |
| 8. Engagement with business incubators in innovative research | 29(7.9%) | 61(16.6%) | 42(11.4%) | 8(2.2%) | 0 | 2.21 | 0.835 | 140 |
| 9. Level participation in technology parks activities | 18(4.9%) | 65(17.7%) | 42(11.4%) | 14(3.8%) | 1(0.3%) | 2.39 | 0.862 | 140 |

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| Items | None | Low | Moderate | High | Very High | Mean | Std. Dev. | N |
|--|----------|-----------|-----------|----------|-----------|------|-----------|-----|
| 10. Industry co-funding of your university innovation activities | 24(6.5%) | 70(19.1%) | 42(11.4%) | 4(1.1%) | 0 | 2.19 | 0.745 | 140 |
| 11. Level of commercialization of 1 invention | 25(6.8%) | 77(21.0%) | 29(7.9%) | 9(2.5%) | 0 | 2.16 | 0.789 | 140 |
| 12. Commercialization of innovative ideas of start-ups or spin-offs. | 31(8.4%) | 75(20.4%) | 32(8.7%) | 2(0.5%) | 0 | 2.04 | 0.714 | 140 |
| 13. Transfer of university-generated intellectual property rights to industry. | 35(9.5%) | 71(19.3%) | 30(8.2%) | 4(1.1%) | 0 | 2.02 | 0.763 | 140 |
| 14. Licensing of products and process patent/copyrights to firms | 35(9.5%) | 73(19.9%) | 26(7.1%) | 6(1.6%) | 0 | 2.02 | 0.782 | 140 |
| 15. Rate of secondments /sabbatical of university staff to industry | 21(5.7%) | 76(20.7%) | 34(9.3%) | 8(2.2%) | 1(0.3%) | 2.23 | 0.799 | 140 |
| 16. Rate of staff participation internship programs to industries | 21(5.7%) | 81(22.1%) | 24(6.5%) | 14(3.8%) | 0 | 2.22 | 0.823 | 140 |
| 17. Rate of adjunct faculty in industry participants | 24(6.5%) | 84(22.9%) | 29(7.9%) | 3(0.8%) | 0 | 2.08 | 0.679 | 140 |
| 18. Rate of undergraduate industry experience training | 2(0.5%) | 40(10.9%) | 63(17.2%) | 31(8.4%) | 4(1.1%) | 2.96 | 0.826 | 140 |
| 19. Rate of postgraduate internship training | 22(6.0%) | 64(17.4%) | 48(13.1%) | 6(1.6%) | 0 | 2.27 | 0.776 | 140 |
| 20. Intensity of organizing and attending conferences/public lectures/seminars | 1(0.3%) | 44(12.0%) | 70(19.1%) | 22(6.0%) | 3(0.8%) | 2.87 | 0.757 | 140 |

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| Items | None | Low | Moderate | High | Very High | Mean | Std. Dev. | N |
|---|-------------|--------------|--------------|------------|-----------|------|-----------|-----|
| 21. Commitment to developing networks through organized social events | 1(0.3%) | 56(15.3%) | 70(19.1%) | 12(3.3%) | 1(0.3%) | 2.69 | 0.669 | 140 |
| 22. Organizing and attending exhibitions and tradeshowes | 10(2.7%) | 71(19.3%) | 46(12.5%) | 13(3.5%) | 0 | 2.44 | 0.761 | 140 |
| 23. Building of relationships through attending anniversary events | 9(2.5%) | 54(14.7%) | 60(16.3%) | 17(4.6%) | 0 | 2.61 | 0.784 | 140 |
| 24. Intensity of postgraduate training of your university staff | 10(2.7%) | 41(11.2%) | 60(16.3%) | 26(7.1%) | 3(0.8%) | 2.79 | 0.902 | 140 |
| 25. Access to R&D incentives and grants in your university | 12(3.3%) | 57(15.5%) | 61(16.6%) | 10(2.7%) | 0 | 2.49 | 0.754 | 140 |
| 26. Availability of appropriate reward systems for researchers | 20(5.4%) | 79(21.5%) | 31(8.4%) | 10(2.7%) | 0 | 2.22 | 0.778 | 140 |
| Grand Total | 475(13.05%) | 1683(46.24%) | 1162(31.92%) | 301(8.27%) | 19(0.52%) | 2.37 | 0.79 | |

Innovativeness of Universities in Nigeria

Table 3 presents results on innovativeness of Universities in Nigeria, under which the first item - 'Upsurge in R&D output' revealed that the following responses were selected respondents as; low = 68(18.5%), moderate = 50(13.6%), none = 16(4.4%) and high = 6(1.6%), while the 'very high' recorded zero score. The mean and standard deviation are 2.33 and 0.734 respectively. On the item of 'increase in the number of patents' the result revealed that; low = 72(19.3%), moderate = 39(10.6%), none = 23(6.3%), high = 5(1.4%) and very high = 1(0.3%), while the mean and standard deviation are 2.21 and 0.782 respectively. Also, the item of 'surge in product innovation' the result showed that; low = 73(19.9%), moderate = 39(10.6%), none = 18(4.9%) and high = 10(2.7%), while very high

obtained zero score. The mean and standard deviation for the item is: 2.29 and 0.782 respectively.

From the item 'flow in institutional research funding', the responses, frequencies and percentiles are; low = 71(19.3%), moderate = 53(14.4%), none = 8(2.2%), high = 6(1.6%) and very high = 2(0.5%), while the mean and standard deviation are 2.45 and 0.733. From the second item 'increase in process innovation' the responses, frequencies and percentiles are; low = 80(21.8%), moderate = 41(11.2%), high = 10(2.7%), none = 7(1.9%) and very high = 2(0.5%), while the mean and the standard deviation are 2.43 and 0.760. More so, from the third item 'increase in copyrights', the responses, frequencies and percentiles are: low = 69(18.8%),

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moderate = 46(12.5%), none = 17(4.6%), high = 7(1.9%) and very high = 1(3%). The mean and standard deviation are 2.33 and 0.781 respectively. The grand total of all the respondents' ratings for 'none', 'low', 'moderate',

'high', and 'very high', 'mean' and 'standard deviation' are 89(10.60%), 433(51.55%), 268(31.90%), 44(5.24%), 6(0.71%), 2.34 and 0.762 respectively.

TABLE 3: DESCRIPTIVE STATISTICS OF UNIVERSITY INNOVATIVENESS

| Items | None | Low | Moderate | High | Very High | Mean | Std. Dev. | N |
|---|-------------------|--------------------|--------------------|------------------|-----------------|-------------|--------------|-----|
| 1. Upsurge in R&D output | 16(4.4%) | 68(18.5%) | 50(13.6%) | 6(1.6%) | 0 | 2.33 | 0.734 | 140 |
| 2. Increase in the number of patents. | 23(6.3%) | 72(19.6%) | 39(10.6%) | 5(1.4%) | 1(0.3%) | 2.21 | 0.782 | 140 |
| 3. Surge in product innovation | 18(4.9%) | 73(19.9%) | 39(10.6%) | 10(2.7%) | 0 | 2.29 | 0.782 | 140 |
| 4. Flow in institutional research funding | 8(2.2%) | 71(19.3%) | 53(14.4%) | 6(1.6%) | 2(0.5%) | 2.45 | 0.733 | 140 |
| 5. Increase in process innovation | 7(1.9%) | 80(21.8%) | 41(11.2%) | 10(2.7%) | 2(0.5%) | 2.43 | 0.760 | 140 |
| 6. Increase in copyrights | 17(4.6%) | 69(18.8%) | 46(12.5%) | 7(1.9%) | 1(0.3%) | 2.33 | 0.781 | 140 |
| Grand Total | 89(10.60%) | 433(51.55%) | 268(31.90%) | 44(5.24%) | 6(0.71%) | 2.34 | 0.762 | |

Strategies for Accelerating UIC and Innovation

Table 4 presents result on strategies for accelerating UIC and innovation amongst Nigerian Universities. The first item, 'Your university's level of engagement with a broad range of companies rather than a few in research activities and advisory capacity in faculties and centres of research and innovation' has revealed the following responses: low = 61(16.6%), moderate = 49(13.4%), none = 24(6.5%), high = 6(1.6%),

while no response was obtained from very high; however, the mean and standard deviation are 2.26 and 0.792 respectively. On the second item, 'your university's effort to pursue corporate-sponsored research offers available in any sector across the world rather than limited to local environment' revealed responses as: low = 55(15.0%), moderate = 51(13.9%), none = 18(4.9%), high = 13(3.5%) and very high =

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3(0.8%) while the mean and standard deviation are 2.49 and 0.909. Also, the next item 'your university's ability to determine the extent of establishing clear framework of Intellectual Property Rights agreement prior to commencement of collaboration with industries' has revealed that: moderate = 59(16.1%), low = 48(13.1%), none = 19(5.2%), high = 12(3.3%) and very high = 2(0.5%) with the mean and standard deviation as 2.50 and 0.886.

From the item 'your university level of engaging industry experts with corporate hands-on experience to participate in faculty research and innovation activities', the responses are: low = 61(16.6%), moderate = 46(12.5%), none = 18(4.9%), high = 11(3.0%) and very high = 4(1.1%) with the mean and standard deviation as 2.44 and 0.916. On the next item 'your university's level of seeking guidance on the technologies and techniques required to put theory into practice and

convert their ideas into process, services and products innovation with potential benefit to society' revealed that: low = 53(14.4%), moderate = 47(12.8%), none = 21(5.7%), high = 15(4.1%) and very high = 4(1.1%). And the mean and standard deviation are 2.49 and 0.97. The last item 'your university's level of readiness to adopt inventive methods to integrating new technology associated skills in the curriculum while continuing to teach the fundamentals of each discipline' has revealed that: moderate = 58(15.8%), low = 37(10.1%), high = 23(6.3%), none = 15(4.1%) and very high = 7(1.9%); with 2.79 and 1.009 as the mean and standard deviation. The total of all the respondents' ratings for 'none', 'low', 'moderate', 'high', and 'very high', 'mean' and 'standard deviation' are 115(13.69%), 315(37.50%), 310(36.90%), 80(9.52%), 20(2.38%), 2.50 and 0.914 respectively.

Table 4: DESCRIPTIVE STATISTICS ON STRATEGIES FOR ACCELERATING UIC AND INNOVATION

| Items | Very Low | Low | Moderate | High | Very High | Mean | Std. Dev. | N |
|--|----------|-----------|-----------|----------|-----------|------|-----------|-----|
| 1. Engagement of many companies rather than a few in research activities | 24(6.5%) | 61(16.6%) | 49(13.4%) | 6(1.6%) | 0 | 2.26 | 0.792 | 140 |
| 2. Pursuit of corporate-sponsored international research offers. | 18(4.9%) | 55(15.0%) | 51(13.9%) | 13(3.5%) | 3(0.8%) | 2.49 | 0.909 | 140 |
| 3. Capacity to develop clear framework of Intellectual Property Rights agreement | 19(5.2%) | 48(13.1%) | 59(16.1%) | 12(3.3%) | 2(0.5%) | 2.50 | 0.886 | 140 |
| 4. Engagement of industry | 18(4.9%) | 61(16.6%) | 46(12.5%) | 11(3.0%) | 4(1.1%) | 2.44 | 0.916 | 140 |

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| Items | Very Low | Low | Moderate | High | Very High | Mean | Std. Dev. | N |
|--|--------------------|--------------------|--------------------|------------------|------------------|-------------|--------------|-----|
| 5. Guidance on adoption of relevant the technologies and techniques. | 21(5.7%) | 53(14.4%) | 47(12.8%) | 15(4.1%) | 4(1.1%) | 2.49 | 0.971 | 140 |
| 6. Readiness to adopt inventive methods to integrating curriculum of various discipline. | 15(4.1%) | 37(10.1%) | 58(15.8%) | 23(6.3%) | 7(1.9%) | 2.79 | 1.009 | 140 |
| Grand Total | 115(13.69%) | 315(37.50%) | 310(36.90%) | 80(9.52%) | 20(2.38%) | 2.50 | 0.914 | |

THE EMERGENT MODEL FOR ACCELERATING THE UIC IN NIGERIA

The responses of the stakeholders illustrated the need for elaborate and effective model of UIC. This is apparent because all the sampled universities appeared to be confronted with difficulties in negotiating a collaboration, weak access to information and affordable transaction costs of finding the right collaborators. Similar justifications have been found in the evidence that number of collaborative R&Ds, innovation activities, Industrial client service offerings, intensity of consulting services, quality control and certification services, use of university-based labs & equipment, engagement with business, extent of commercialization of inventions, and commitment to developing networks appeared to be alarmingly weak. The level of generated innovations across the institutions assessed also appeared to be at significantly low levels which are marked by stumpy R&D outputs, patents, product and process innovations, institutional research funding and copyrights. The implication is that processes which could be used to enhance

innovativeness through UIC remain sub-optimal due to lack of robust framework to realize beneficial outcomes from collaborations. Similarly, new opportunities for research and innovation development that would offer viable advantage to these institutions remain thin due to insufficient research capacities.

When such technical and administrative weaknesses are encountered, emergent approaches are required to help addressing the challenges. Hence, this study was envisioned to introduce a model that would facilitate effective collaboration between the key actors in the triple-helix that would ultimately accelerate innovation emanating from the university systems. The proposed model as shown in Fig. 5, is built on the original triple helix model which focused on three key players, i.e. university, industry, and government but with an extension of modified functions targeted at generating innovation through successful and effective collaborations between university and industry supported by government.

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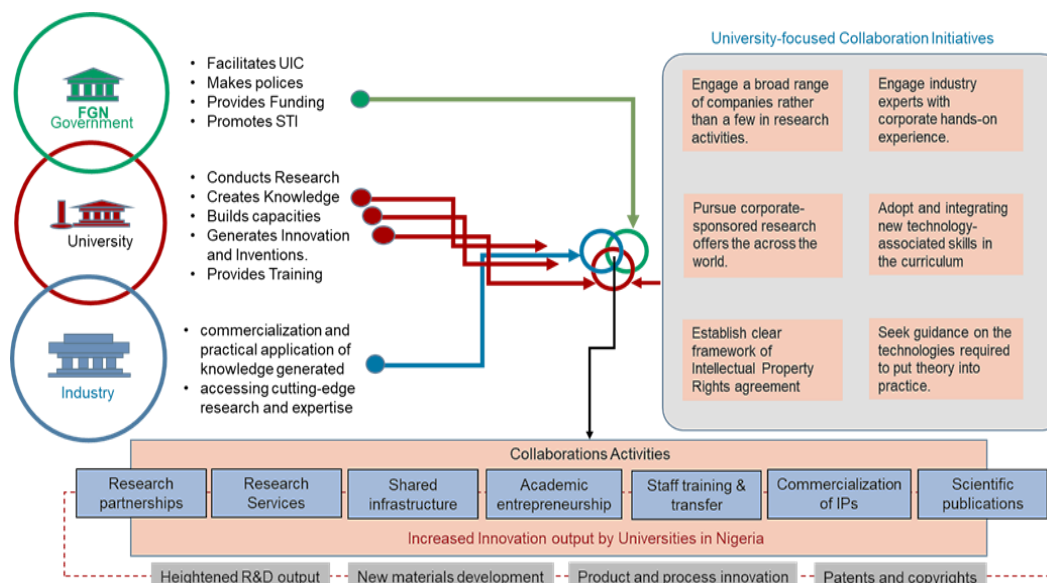


Figure 5: Proposed UIC Model

the universities to generate innovation. This could be effectively achieved when universities actively deploy the following elements of the model.

Fig 5 presented the proposed model based on integration between university, industry, and government with active roles on the side of

TABLE 5: ENGAGE A BROAD RANGE OF COMPANIES RATHER THAN A FEW IN RESEARCH ACTIVITIES

| Approach | Strategic Actions | Benefits to Universities |
|--|--|--|
| Emphasis on strategic Research Planning | <ul style="list-style-type: none"> Identification of global trends and challenges as well as understanding the growing needs of industrial sectors and the global society. The universities should target research on emerging society challenges, technology solutions, and sustainable improvement [17, 23]. | <ul style="list-style-type: none"> Diversified funding sources. Expanded research scope. |
| Adopt a global research approach | <ul style="list-style-type: none"> Defining clear research priorities and aligning them not only with the local university's strengths but also with global needs [4]. | <ul style="list-style-type: none"> Access to an extensive array of resources and expertise. |
| Promoting interdisciplinary collaboration | <ul style="list-style-type: none"> Encourage research across different knowledge boundaries to address complex societal challenges [33]. | <ul style="list-style-type: none"> Foster stronger connections between academia and the wider business world. |

TABLE 6: PURSUE GLOBAL CORPORATE-SPONSORED RESEARCH OPPORTUNITIES

| Approach | Strategic Actions | Benefits to Universities |
|---|--|---|
| Align Research with Industry Needs | <ul style="list-style-type: none"> Universities should identify research areas that align with the strategic goals and emerging needs of global corporations. | <ul style="list-style-type: none"> Generate industry research funding. |

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| Approach | Strategic Actions | Benefits to Universities |
|--|--|---|
| Active Sourcing of Opportunities: | <ul style="list-style-type: none"> This can involve identifying unmet research needs and adapting research projects to address those needs [16]. Universities need to actively search for research funding opportunities, both domestically and internationally. This includes tracking grant announcements, attending conferences, and networking with industry leaders to identify potential sponsors [28, 34]. | <ul style="list-style-type: none"> Real application of investigations. Wider financial resource generation. Robust and strong industry-academia alignment and networks. Long lasting collaboration. |
| Building Relationships with Corporate Partners: | <ul style="list-style-type: none"> Establishing strong relationships with corporate partners is crucial for success. This involves building trust and rapport through open communication, collaborative projects, and regular engagement [15, 31]. | <ul style="list-style-type: none"> Increase chances of commercialization openings. |
| Adopting a global research approach | <ul style="list-style-type: none"> Defining clear research priorities and aligning them not only with the local universities strengths but also with global needs [15, 31]. | |
| Promoting interdisciplinary collaboration | <ul style="list-style-type: none"> Encourage research across different knowledge boundaries to address complex societal challenges [33]. | |

TABLE 7: ESTABLISH CLEAR FRAMEWORK OF IPRS AGREEMENT PRIOR TO COMMENCEMENT OF COLLABORATION WITH INDUSTRIES

| Approach | Strategic Actions | Benefits to Universities |
|--|--|--|
| Carryout intellectual property audits | <ul style="list-style-type: none"> Identifying university valuable IP assets such as copyrights inventions, trademarks, patents, scientific discoveries secrets, and innovative knowledge and technical know-how [1]. | <ul style="list-style-type: none"> Safeguard of valued intellectual property assets |
| Develop detailed agreements. | <ul style="list-style-type: none"> Outlining clear ownership of the IP emanating from the collaboration activities. This would also include defining the scope of rights granted to each party, including usage, distribution, and commercialization rights, confidentiality clauses to protect trade secrets and sensitive information, duration, territory, and permitted uses; conditions under which the agreement can be terminated and the procedures for resolving disputes [6, 18, 24]. | <ul style="list-style-type: none"> Clear legal framework for collaboration. Minimize disputes and disagreements. |
| Deploy effective enforcement mechanisms | <ul style="list-style-type: none"> This could be done through Monitoring of potential violations and taking appropriate enforcement actions. This may include brand protection by registering trademarks and copyrights to strengthen legal protection and facilitate enforcement, obtaining legal guidance from experts to ensure the sanctity and enforceability of IP agreements [30]. | <ul style="list-style-type: none"> Prevention against IP stealing. Improved capability to commercialize research outcomes. |
| Adopt technology | <ul style="list-style-type: none"> By employing IP management systems to keep trail and manage IP assets, agreements, and enforcement actions. | |

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| Approach | Strategic Actions | Benefits to Universities |
|---------------------|---|--|
| Plan for the future | <ul style="list-style-type: none"> This could be done through the use of online platforms for brand registry and infringement detection as well as adoption of digital rights management tools to control access and usage of digital IP [35]. This could be achieved by maintaining a framework that could easily adapt to future changes in research focus, technology, UIC models, and legal frameworks. Ensure that IP arrangement flexible and can be modified to suit new and developing situations [13, 22]. | <ul style="list-style-type: none"> Enhance management and tracking of IP assets. Improved compliance monitoring. Compliance to future changes in research and legal landscapes. |

TABLE 8: ENGAGE INDUSTRY EXPERTS WITH CORPORATE HANDS-ON EXPERIENCE TO PARTICIPATE IN FACULTY RESEARCH AND INNOVATION

| Approach | Strategic Actions | Benefits to Universities |
|---|---|---|
| Cultivate robust associations | <ul style="list-style-type: none"> By identifying and connecting with targeted industry experts who are known to be specialized in specific research domains and university innovative orientation. This could be done through personalized engagement with mutual understanding on research projects. It can further be optimized by organizing events that attract faculty and industry professionals [21, 29]. | <ul style="list-style-type: none"> Access to specialized industry knowledge and hands-on experience. Improved research relevance. Chances for faculty staff and students to work on real-world problems. Improved talent development and inclusivity. |
| Suggest research proposition of distinct significance | <ul style="list-style-type: none"> By offering opportunities for engaging in cutting-edge research, knowledge exchange, implementing impactful tangible projects to address real community challenges, generating talents and inclusivity [12, 33]. | <ul style="list-style-type: none"> Expanded professional networks for faculty and students. Increased potential for impactful and tangible projects within the society. |
| Enable knowledge sharing | <ul style="list-style-type: none"> Through conferences, workshops, seminars, publications of scientific research findings and professional networking [29]. | <ul style="list-style-type: none"> Leads to stronger industry-academia relationship. Exposure to state-of-the-art technologies. |
| Leverage existing partnerships: | <ul style="list-style-type: none"> This can also involve attending industry events, networking with corporate representatives, and forming strategic alliances.[12, 22, 23] | |

TABLE 9: SEEK GUIDANCE ON THE TECHNOLOGIES AND TECHNIQUES REQUIRED TO PUT THEORY INTO PRACTICE WITH POTENTIAL BENEFIT TO SOCIET

| Approach | Strategic Actions | Benefits to Universities |
|----------------------|---|---|
| Instituting learning | <ul style="list-style-type: none"> To provide guidance and support on using specific technologies for research | <ul style="list-style-type: none"> Enhanced application of theory to practice. |

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| Approach | Strategic Actions | Benefits to Universities |
|--|---|---|
| enhancement centres | and teaching. The centres could do so by providing access to online resources that could facilitate teaching and research [5]. | <ul style="list-style-type: none"> Leveraged technology to enhance teaching and research capabilities. |
| Capacity Development | <ul style="list-style-type: none"> In which the universities would facilitate and offer access to regular training of faculty through development programs, seminars, Workshops and other innovative learning initiatives [6, 19]. By which relevant technologies are added into courses contents which would also motivate learners to apply digital tools in research activities. This would further require introduction of specialized courses aimed at developing specific talents deep-rooted knowledge in targeted areas [34]. | <ul style="list-style-type: none"> Faculty and students' acquisition of specialized skills. Modernized curriculum, teaching and research infrastructure relevant to societal needs. |
| Curriculum optimization | | <ul style="list-style-type: none"> Access to advanced digital learning tools and platforms. |
| Deploying and adapting to digital technologies | <ul style="list-style-type: none"> Providing access cloud-based platforms, virtual reality, AI in leaning management systems [22, 31]. | <ul style="list-style-type: none"> Ready-made future graduates. Gaining competitive advantage. |

TABLE 10: PREPARE TO ADOPT INVENTIVE METHODS TO INTEGRATE NEW TECHNOLOGY AND ASSOCIATED SKILLS IN THE CURRICULUM WHILE CONTINUING TO TEACH THE FUNDAMENTALS OF EACH DISCIPLINE

| Approach | Strategic Actions | Benefits to Universities |
|---|--|--|
| Adopting Blended Learning | <ul style="list-style-type: none"> By combining virtual learning with traditional instructional methods which provide opportunity for flexibility and personalized learning experiences [21]. | <ul style="list-style-type: none"> Increased flexibility and more personalized learning experiences for students. Makes learning more engaging and real for students, further simplifying learning complex topics. |
| Applying new educational platforms | <ul style="list-style-type: none"> By making learning more engaging and pleasing in difficult and intricate courses [12]. | <ul style="list-style-type: none"> Ubiquitous student reach. |
| Foster engagement in practical projects | <ul style="list-style-type: none"> by encouraging learners to apply technology skills and knowledge to remedy practical societal challenges [1, 3, 22]. | <ul style="list-style-type: none"> Promotion of active and collaborative learning environments. Prepared students for real-world tasks and challenges. |
| Encourage active learning | <ul style="list-style-type: none"> By providing active role to learners through collaborative and interactive activities, models building, simulations, using digital tools [6, 31]. | <ul style="list-style-type: none"> Development of critical thinking skills. Improved learning experience. Greater motivation for students. |

DISCUSSION AND IMPLICATIONS

The study presented a collaborative framework of techniques for improving university-

industry interactions. The review of related literature highlighted the growing interest and efforts in promoting 'global best practices' for the

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establishment of collaborations. The study revealed that the data is fragmented, and need for comprehensive data on the best practices for developing and managing academia and industry collaborations. The review of literature and data analysis showed that a variety of elements influence the success of collaborations. It highlighted various types of interactions, challenges, needs, people, social capital, basic partnership features, communication, dissemination, intellectual property, strategy, technology transfer and policy as elements considered in this framework for enhancing collaborative effectiveness. The study reveals that ensuring the quality of underlying variables will result in a successful collaboration.

The complexity of the collaboration process makes it impossible to predict a successful recipe. However, the suggested collaborative framework is projected to improve cooperation effectiveness since it takes a holistic approach and focuses on the driving causes and enablers of successful collaboration rather than methods. It aims to provide the required instructions to diverse stakeholders for establishing and maintaining successful collaborations. While the methodology presented here focuses on universities it is believed to have broader applicability and assist other stakeholders in the ecosystem.

The complexity of the collaboration process makes it impossible to predict a success trajectory. However, the suggested collaborative framework is projected to enhance cooperation effectiveness since it takes a holistic approach and focuses on the driving causes and enablers of successful collaboration rather than methods. It aims to provide the required instructions to diverse stakeholders for establishing and maintaining successful collaborations. While the framework presented here focuses on universities, it is believed to have broader application and assist other stakeholders in the environment. It is recognised that the sample size use for this study is adequate across many disciplines in the university environment in Nigeria, which indicated the quality of the collected data. Therefore, the study might have the potential for external validity

that allows for applicability of findings beyond Nigerian contexts for robust UIC framework.

Furthermore, the proposed UIC framework has the following implications. It provides a theoretical contribution knowledge advancement in the area of UIC. To the best of understanding of the authors, the study is amongst the first that attempts to harmonise variety of best practices in a single study in Nigeria as emphasized by the literature review on the relevance of best practice in achieving of UICs. The study possessed managerial significance as it provides useful framework for practical application in making informed decisions that can improve the effectiveness of UICs. The findings are particularly relevant in the context of Nigeria, where the government need to increase its efforts to stimulate UICs. The study anticipates that implementing the framework in practical-life situations will result in the formation of more robust best practices that can be employed in future in a similar context.

Achievements of the Study

1. Development of an Enhanced UIC Model:

the research was able to reach beyond the traditional triple helix model, developed an enhanced framework integrating six additional key elements for accelerating University-Industry Collaborations (UICs) and enhancing innovation within the Nigerian context to address key inherent issues and opportunities within the UIC ecosystem in Nigeria.

2. Evaluated and Identified Gaps within the Existing UIC Models: in-depth analysis was conducted within extant review of literature on existing UIC models revealing an advancement from an orthodox partnership to a more formal structured collaboration. Gaps were identified, specifically those related to their applicability and effectiveness in the Nigerian domain.

3. Evaluated Key Findings from Existing UIC and Innovativeness in Nigerian Universities:

the study findings from the survey carried out revealed that although there is an increase in awareness and interest in UICs, in reality, the level of partnership and its effect in the Nigerian universities is still low. Such findings include low



funding, limited formal collaborations, limited rate of commercialization activities, frail TTOs and so on.

4. Identification of Additional Key Components and Mechanisms in the Enhanced Model: the proposed model outlines specific inter-related components such as: the university, industry, government, informal sector, funding and investment mechanisms, intermediary institutions, cultural and trust building; and mechanisms for acceleration which include: policy coherence and implementation, demand-driven research, capacity building, network and ecosystem development, performance metrics and incentives.

5. Policy and Practical Implications: the research outlined suggestion for policy formulation and inclusion within the realm of UICs in the Nigerian ecosystem. This includes proposal for the need for a sustainable funding models, an integrated national innovation policy, IP framework reform, and strengthening the intermediary institutions. In addition to the provision of practical guidance for all the stakeholders involved.

6. Gap for Future Research: several avenues for future studies have been identified that is required to be filled by scholars in the academia and beyond. These include among others, an empirical validation of the proposed model, deeper investigation into intermediary institutions, analysis of cultural and trust factors, comparative studies, and the development of robust metrics for measuring innovation outcomes associated with UIC.

CONCLUSIONS

The study proposed a comprehensive framework for improving UIC and innovativeness in Nigeria. The study framework was derived based on the data collected as well as the review of extant literature. The study revealed that the practice of UICs in Nigeria is dispersed, in which this framework attempts to provide a comprehensive best practice. The framework is informed based on the findings from quantitative responses collected on the nature, extent, and effect of UICs including the perceived drivers and

inhibitors of innovation within the academia from public and private universities in Nigeria. The study contributes to the advancement of knowledge regarding UIC and improved innovativeness. With the adoption of the proposed framework, an effective collaboration could be established between universities and industries under the government effort in providing the enabling environment for successful collaboration. Future studies may consider advancing the proposed framework.

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