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Bridging the gaps and building synergy: A Survey of University-Industry Collaboration for Engineering Students Research Activities of Selected Nigerian Industries and Universities

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Abstract

This study surveyed university-industry collaboration for engineering student research in Nigeria, involving selected universities and diverse industrial sectors. Key findings indicate strong industry willingness to collaborate (100% participation), driven by the desire for future employees and innovative ideas. However, significant systemic challenges impede effectiveness, primarily pervasive communication gaps (91.7% of respondents) and a misalignment between university research and industry needs. A notable deficiency is that 70% of industries lack formal Research and Development (R&D) policies, limiting structured partnerships. Additionally, critical skill gaps were identified in students, particularly in data analysis and research formulation. The report recommends strengthening these vital relationships through enhanced research relevance, improved communication, and targeted student training. Addressing these barriers is crucial for leveraging Nigeria's innovation potential, fostering economic growth, and developing a skilled workforce for national advancement.

Keywords: University-Industry Collaboration; Nigeria; Needs Assessment; Research Gaps; Skill Deficiencies; Communication Gaps; R And D Policies

1. Introduction

University-industry collaborations are globally recognized as essential for innovation, economic growth, and societal progress [1,2,3]. This synergy is vital for addressing complex real-world challenges, fostering applied research, and equipping students with the practical skills needed for successful careers [1,4]. Recent research indicates a substantial engineering skill gap among new Nigerian university graduates, largely due to inadequate practical training during their studies [5]. This deficit is also evident in the automotive industry, where Agboneni et al. [6] highlight the need for specialized training programs to promote sustainable safety practices. Given Nigeria's developmental aspirations and

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the critical role of local and professional expertise as human capital [7,8], robust partnerships between universities and industries are crucial.

The Nigerian government has established a framework for these collaborations through key national policies. The National Policy on Education (2014) mandates tertiary institutions to contribute to national development through manpower training, research and development (R&D), and active collaboration with industries. The goal is to produce a skilled workforce relevant to the labor market [9,10]. Similarly, the Nigeria Industrial Revolution Plan (NIRP), launched in 2014, aims to transform Nigeria into a manufacturing hub for West Africa. This plan emphasizes indigenous skills, innovation and intellectual property rights (IPR), and cross-sectoral consultations involving academic institutions [11,12]. Nigeria Vision 20:20, a long-term development blueprint, also highlights university-industry-government interaction as crucial for commercializing scientific breakthroughs [13].

Even the 1991 Privatization Policy, by encouraging the establishment of state and private universities, indirectly increased potential collaboration points with industry [14,15]. The public sector is also encouraged to provide support through research grants, tax incentives for R&D, and public-private partnership frameworks. The National Information Technology Development Agency (NITDA), through its R&D Department, exemplifies a governmental body actively driving this agenda, fostering innovation, research, and technology transfer between academia, industry, and government [16].

Nigerian universities are also committed to fostering these partnerships, aligning with governmental directives. Many institutions have developed comprehensive research policies. For example, Ahmadu Bello University (ABU), the National Open University of Nigeria (NOUN), and Abubakar Tafawa Balewa University (ATBU) Nigeria have guidelines for ethical practices, resource optimization, and building sustainable research partnerships with industry [17,18,19,20] . Universities are increasingly incorporating industry insights into curriculum development to ensure graduates have relevant skills. Strong emphasis is placed on student industrial training and placement programs to bridge the gap between academic study and practical application [21]. This reflects a growing view that university-industry collaboration promotes demand-driven research [22]. Institutions like Abubakar Tafawa Balewa University, Bauchi, have established dedicated research committees, often with a focus on external engagement, and recommend online platforms to showcase research outputs and intellectual property [20].

From the industrial perspective, there's a growing understanding of the mutual benefits of engaging with academia. Industries are encouraged to co-develop academic curricula and participate in student training programs, ensuring graduates have industry-relevant skills and addressing skill gaps [7,23]). While R&D investment remains a challenge for some Nigerian industries, universities offer access to cutting-edge research, leading to new products and solutions [3,24]. Discussions also suggest establishing local research units within companies, supported by tax incentives, and creating shared research centers, pilot plants, and innovation hubs to foster a more integrated innovation ecosystem.

Despite strong commitments and policies, the collaboration between Nigerian universities and industries is still largely underdeveloped. Yet, such partnerships are crucial for achieving university goals and are fundamental to fostering innovation, driving technological advancement, and producing the skilled workforce necessary for national growth and development [25,8,26]. Reports consistently highlight persistent challenges, including significant communication gaps, misaligned research priorities, and insufficient student preparedness for industry-relevant research. These barriers impede the full realization of potential benefits.

This paper presents a comprehensive needs assessment survey conducted as part of a student engagement activity under the Royal Academy of Engineering – Higher Education Partnership in Sub-Saharan Africa (Rang-HEPSSA) Initiative (Project No. HEPSSA-2425-5-100-116). The project, "Enhancing Engineering Education in Sub-Saharan Africa Through a Research and Innovation Pipeline," aimed to identify gaps in student research across selected universities in Nigeria, Kenya, and Ethiopia during the 2024/25 grant cycle. This paper specifically details the survey's findings on existing collaboration levels, challenges, and opportunities between select Nigerian universities and industry stakeholders, aiming to provide an actionable roadmap for enhancing student research and strengthening the research ecosystem in Nigerian higher education.

The overarching aim of this study is to identify the specific needs of industries and the existing research gaps within Nigerian universities concerning student research, providing a comprehensive assessment of the current state of collaboration. Based on this aim, the study's objectives are to

- Evaluate the nature and extent of existing collaborations between Nigerian industries and public universities on student research projects, examining current engagement levels and types of partnerships.

- Identify the significant challenges and barriers hindering effective student research collaboration between industry and academia, including communication gaps, misalignment of research priorities, intellectual property concerns, and inadequate funding.
- Determine the primary incentives that motivate industries to engage in student research collaboration with universities, such as access to talent, innovative ideas, and problem-solving opportunities.
- Assess key research skill deficiencies observed among students that impede their ability to contribute effectively to industry-relevant R&D projects [27,28].
- Provide actionable recommendations for strengthening university-industry relationships by enhancing research relevance, improving communication, and developing targeted student training programs to bridge identified skill gap.

2. Methodology

This study used a comprehensive survey to assess collaboration between Nigerian universities and industrial partners, focusing on undergraduate student research. It gathered both quantitative and qualitative data to evaluate existing partnerships, identify challenges, and explore strategies for improvement. The research employed a descriptive survey design with a cross-sectional approach, collecting perceptions and factual data from industrial professionals and university stakeholders at a single point in time. Participants were sourced from diverse industrial sectors across Nigeria, including Engineering, Power Generation, Technology, and Oil & Gas, and prominent organizations like Dangote Refinery (refer to Figure 1).

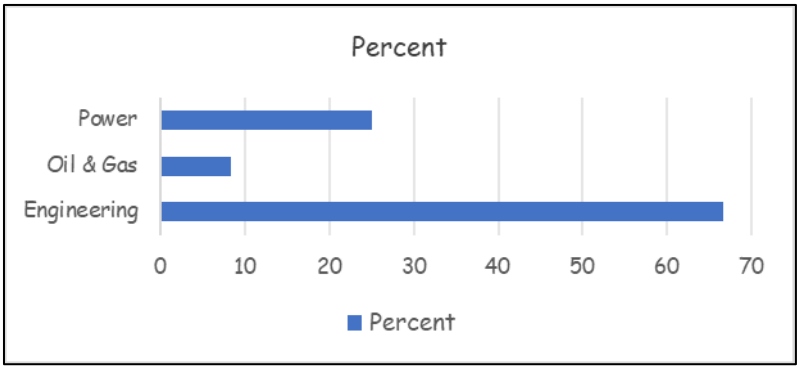

Figure 1 Industrial sectors that participated in the survey

The survey instrument was disseminated to these industrial professionals via email and WhatsApp, utilizing purposive sampling. A meticulously designed Google Form served as the primary data collection instrument. This online questionnaire included structured questions aimed at gathering data on the current state of university-industry collaboration, significant challenges, and perceived opportunities and strategies for strengthening these relationships, particularly concerning undergraduate student research. The questionnaire incorporated both closed-ended questions (e.g., multiple-choice, Likert scale) and potentially open-ended questions to capture a wide range of perspectives.

The data collection procedure involved actively distributing the survey link to workers affiliated with the identified prominent Nigerian industrial entities. A strict deadline of December 31, 2024, was set for survey completion, and all responses were successfully collected upon the closure of the survey period. Upon collection, all responses were downloaded into a spreadsheet for systematic processing. A rigorous data cleaning process was undertaken to remove invalid, incomplete, or inconsistent entries, ensuring data integrity and reliability. Following cleaning, comprehensive data analysis was performed using various data visualization methods to identify key trends, patterns, and insights. This involved calculating frequencies, percentages, and means to summarize demographic characteristics and present the prevalence of reported collaboration levels, challenges, incentives, and skill gaps. Charts and graphs were created to visually represent findings and facilitate understanding of data distributions. The conclusions and recommendations presented in this report are directly drawn from this meticulously analyzed data, providing a robust foundation for future interventions aimed at bolstering university-industry collaboration in Nigeria [29].

3. Key Findings on Industry Engagement

This report presents the key findings from a needs assessment survey on industry-academia collaboration in Nigerian universities, highlighting the current landscape of partnerships, their potential, and the significant challenges that hinder their effectiveness.

3.1. Robust Industry Participation and Local Relevance

The needs assessment survey drew participants from a wide variety of Nigerian industries, including Engineering, Power Generation, Technology, and Oil & Gas. Notable organizations like Dangote Refinery, Egin Power Plc, and the Nigerian Army were among those surveyed. This diverse representation strengthens the study, suggesting its findings are broadly applicable across Nigeria's industrial landscape.

Given that most respondents were based in Nigeria (refer to Fig. 2), the findings are highly relevant locally, helping to address specific national challenges and promote local innovation in university-industry collaborations. This broad and local input ensures the insights are valuable for tackling national issues. Ultimately, the report emphasizes the urgent need for focused actions to close existing gaps and fully realize the potential of these collaborations in Nigeria.

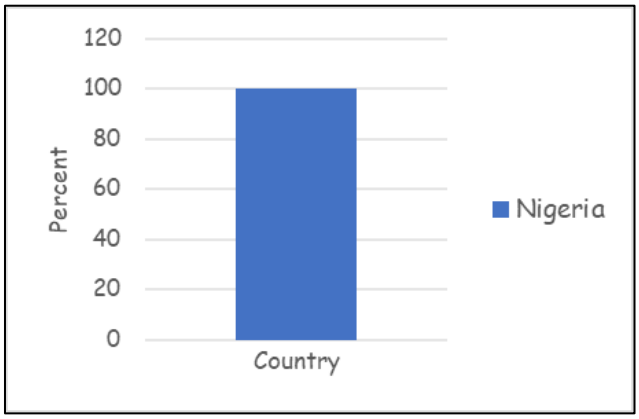

Figure 2 Country of Origin of Respondents

3.2. High Existing Collaboration Rates with Significant Untapped Potential

The survey revealed a high level of engagement between industry and academia, with 100% of industrial respondents confirming active collaborations with Nigerian public universities on various research projects. This widespread participation highlights a clear willingness to partner and an existing connection between these sectors, signaling a strong potential for more extensive collaborations in the future. Industries evidently understand the value of leveraging university talent, accessing cutting-edge research, and utilizing academic resources for innovation and development. This consensus among industrial stakeholders indicates a significant, yet largely unfulfilled, opportunity to expand and deepen these partnerships.

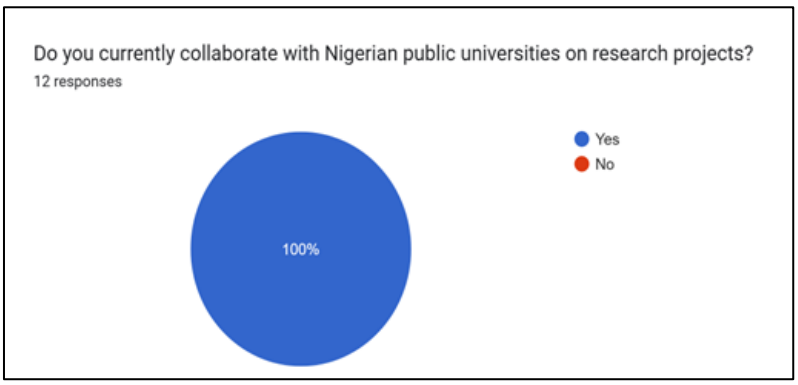

Figure 3 Level of Industry-Academia collaboration

3.3. Critical Deficiency in Formal R&D Policies

Despite a high existing collaboration rate, a significant challenge identified in the survey was that 70% of industrial organizations reported lacking formal R&D policies. This widespread absence of formalized R&D frameworks among industries could severely compromise the effectiveness, long-term viability, and strategic alignment of their collaborative endeavors.

Structured R&D policies are essential for clearly defining research objectives, safeguarding intellectual property, allocating necessary resources, and establishing long-term goals, all of which are critical for maximizing the impact of university-industry partnerships [30,31]. Without these foundational frameworks, collaborative efforts often remain informal, project-specific, and poorly integrated into a company's core strategic objectives. Such R&D policy limitations can, therefore, directly hinder the effectiveness and sustainability of these vital partnerships [32,31].

Nevertheless, even with this clear limitation, a consistent and compelling finding was the strong desire among industries to engage in more extensive and effective collaborations with academia. This consensus among industrial stakeholders indicates a substantial, yet largely undeveloped, potential for deeper and broader partnerships. Industries clearly recognize the value of leveraging university talent, accessing cutting-edge research, and utilizing academic resources for innovation and development. However, this promising potential remains largely unrealized due to various systemic issues affecting the design, delivery, and coordination of collaborative research initiatives.

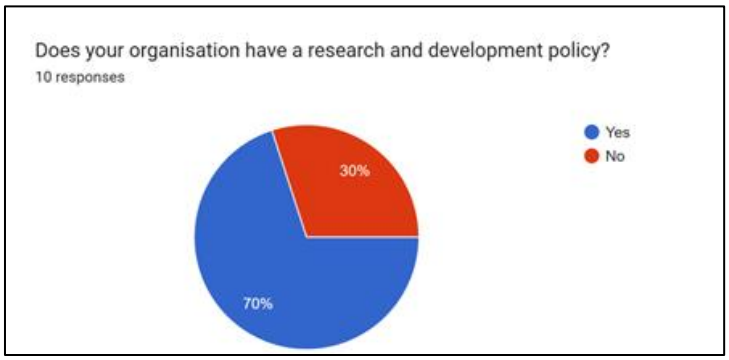

Figure 4 Industries with Research policies

3.4. Significant Challenges Impeding Effective Collaboration

While industries are eager to collaborate, the full potential of these partnerships remains unrealized due to several systemic issues impacting the design, execution, and management of joint research initiatives. A significant impediment, identified by a striking 91.7% of respondents, is the pervasive lack of effective communication and coordination between universities and industries impedes knowledge transfer and further widen the skill gap. Thereby, making it difficult to apply the skills gained through training or practice in real-life, practical situations [7,33]. This breakdown frequently results in uncoordinated research efforts and missed opportunities for innovation.

Furthermore, nearly half of the respondents (41.7%) highlighted a misalignment in research priorities, noting that universities often lack expertise in areas directly relevant to industry needs. This makes it challenging to identify suitable projects and address concerns regarding intellectual property rights, indicating that academic research often does not align with industrial demands. These systemic problems frequently lead to difficulties in applying research findings in real-world settings and bringing them to market, which further limits the overall impact of these collaborations. Addressing these fundamental issues is crucial for transforming expressed interest into tangible, impactful, and sustainable university-industry partnerships that can propel Nigeria's innovation agenda forward.

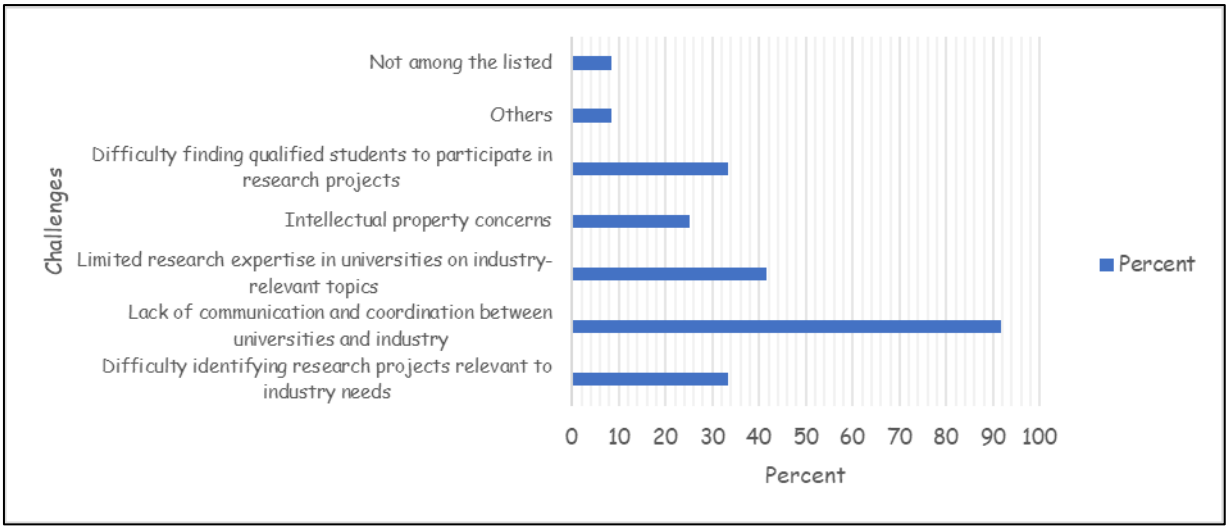

Figure 5 Challenges bedeviling research endeavors in Nigerian industries

3.5. Compelling Incentives for Collaboration

Even with the existing challenges, industries clearly recognize the powerful incentives for collaborating with universities. The main reasons businesses engage with academia are to find future employees and gain access to innovative ideas, with a significant 83.3% of respondents citing these factors [1,3,34]. Other important motivators, each cited by 41.7% of respondents, include tax benefits and the chance to influence the direction of academic research. These findings highlight that; industries see universities as crucial sources of fresh perspectives and intellectual capital.

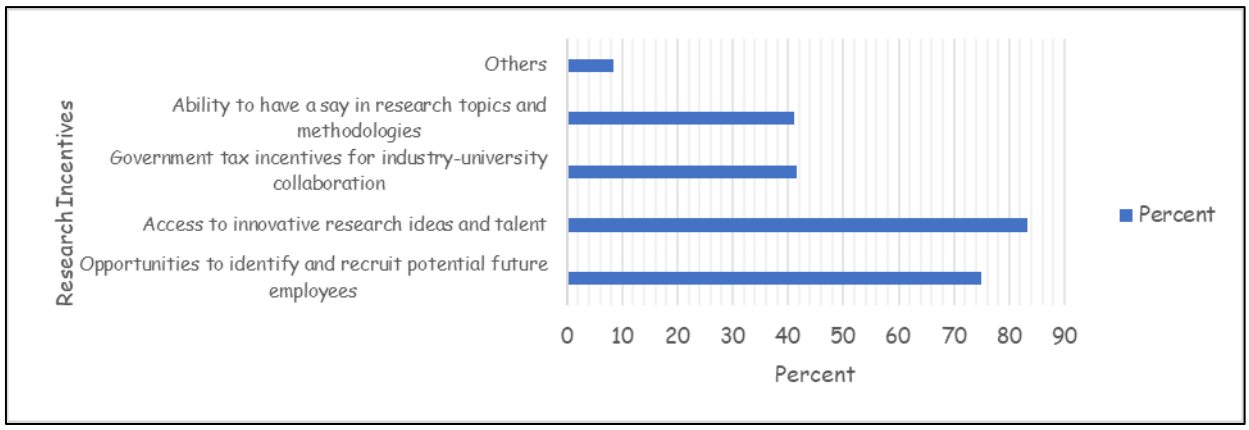

Figure 6 Incentives for student research activities

3.6. Critical Skill Gaps Among Graduates

The survey identified significant weaknesses in students' research skills, directly impacting their ability to contribute to industry-specific research. A key finding was that 83.3% of respondents reported students lacked adequate data analysis and interpretation skills. Other notable skill gaps included a deficiency in conducting thorough literature reviews (58.3%) difficulty formulating clear research questions (50%), and limited hands-on

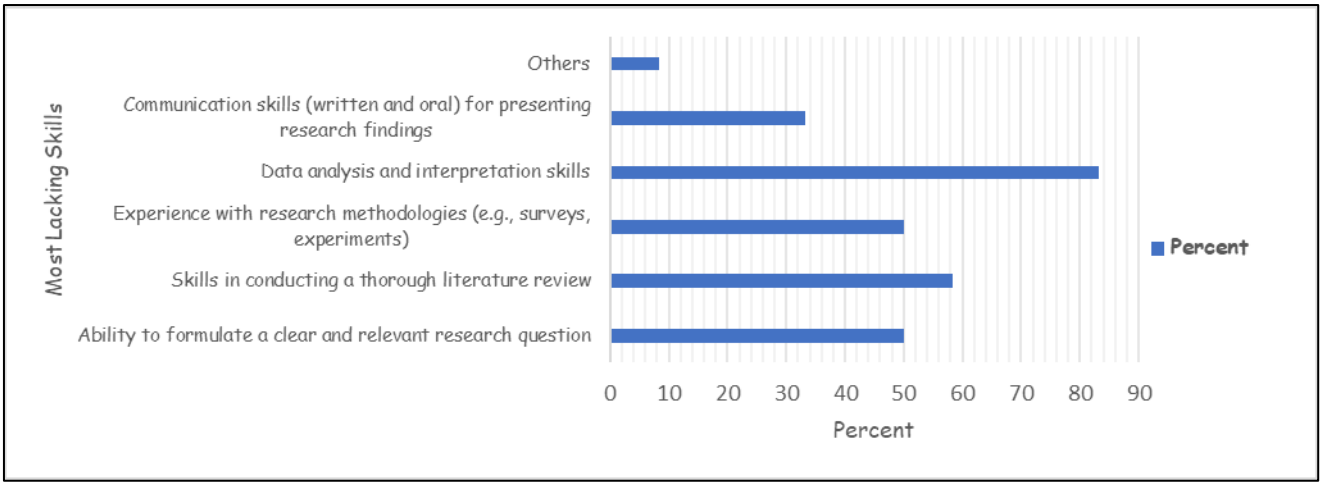

Figure 7 Research skills gap among students

experience with various research methods such as surveys, experiments, and case studies (50%). Furthermore, 33.3% of respondents observed weak written and oral communication skills when presenting research findings, underscoring the need for improved training in scientific writing and presentation. Collectively, these skill deficits suggest a disconnect between university education and the practical research competencies required in industrial environments.

4. Discussion of the Findings of the Survey

The findings from this needs assessment survey further reveals the complex dynamics of university-industry collaboration for engineering student research in Nigeria, revealing both significant potential and entrenched systemic barriers. This discussion interprets the key results, highlights their implications, acknowledges the study's limitations, and proposes avenues for future research.

4.1. Interpretation of Results and Implications

The survey's most compelling finding is the universal active engagement (100%) of surveyed industrial organizations in research projects with Nigerian public universities. This signals a fundamental, ingrained recognition within the industrial sector of the inherent value that universities can contribute, particularly in talent development and access to innovative ideas. This high level of existing (though potentially informal) collaboration serves as a robust foundation upon which more structured and impactful partnerships can be built. It implies that the primary challenge is not a lack of willingness to collaborate, but rather an inadequacy in the mechanisms and frameworks supporting effective collaboration. The strong incentives, particularly the desire to identify future employees and gain access to innovative ideas (83.3%), further underscore industries' strategic interest in academic partnerships, viewing universities as vital pipelines for intellectual capital and fresh perspectives. This finding aligns with global trends where industries increasingly rely on universities for innovation and talent acquisition, but its universality in the Nigerian context is particularly noteworthy.

However, the pervasiveness of communication and coordination gaps, cited by 91.7% of respondents, represents the single most critical impediment. This communication breakdown directly contributes to the misalignment between university research and industry needs, where nearly half of respondents (41.7%) highlighted limited university expertise in industry-relevant topics. This suggests a disconnect between academic output and industrial demand. Effective dialogue and structured platforms for engagement are crucial to bridge this gap, ensuring that university research is not only academically rigorous but also practically applicable and economically relevant. The absence of clearly defined intellectual property frameworks and established pathways for integrating industrial feedback further exacerbates this misalignment, creating uncertainty and disincentives for deeper collaboration.

The finding that 70% of surveyed organizations lack formal R&D policies is profoundly significant. This deficiency in formal structures can lead to ad-hoc, inconsistent, and less impactful engagements. Formal R&D policies provide the necessary framework for strategic collaboration, resource allocation, intellectual property management, and long-term objective setting. Their absence hinders the institutionalization and sustainability of partnerships, reducing them to opportunistic ventures rather than core strategic initiatives. This implies a need for targeted interventions within the

industrial sector to develop and implement such policies, thereby creating a more fertile ground for robust university-industry linkages.

Furthermore, the identified critical skill deficiencies among students, particularly in data analysis and interpretation (83.3%), literature review (58.3%), research question formulation (50%), practical methodologies (50%), and communication (33.3%), highlight a significant mismatch between university training and the applied competencies required by industry. While universities are responsible for foundational knowledge, the survey points to a gap in practical, industry-relevant research skills. This has direct implications for student employability and the quality of contributions they can make to collaborative projects. It underscores the urgent need for curriculum reform, increased experiential learning opportunities (e.g., internships, industry-led projects), and enhanced scientific communication training within universities to better prepare graduates for industrial research environments.

4.2. Theoretical Discussion of the Study's Findings

The findings of this study on university-industry collaboration in Nigeria can be comprehensively discussed through an integrated theoretical lens, primarily leveraging the Triple Helix Model, complemented by insights from Institutional Theory and Human Capital Theory. This combined approach allows for an understanding of the macro-level systemic interactions, the micro-level organizational behaviors, and the crucial role of skills and talent in driving innovation.

4.2.1. The Triple helix model: An overarching framework for systemic interactions

The Triple Helix Model proposes that innovation and economic development are increasingly driven by the dynamic interplay among universities, industry, and government [35]. This study examines the Nigerian context, revealing emerging interactions, dysfunctional linkages, and policy deficiencies within this framework.

Evidence from the study strongly validates the foundational premise of the Triple Helix: a universal (100%) active engagement of industrial organizations with universities indicates a clear desire for interaction between these spheres. Industries are primarily motivated by the need to identify future employees and gain access to innovative ideas, demonstrating the push and pull factors for collaboration inherent in this model. This signifies a recognition of the university's evolving role beyond traditional teaching to that of a more economically relevant actor. However, significant inefficiencies hinder the interactive processes of Nigeria's Triple Helix. Pervasive communication and coordination gaps (91.7%), coupled with a misalignment between university research and industry needs, highlight these challenges. For a robust Triple Helix, seamless knowledge transfer and iterative feedback loops are essential. The observed challenges indicate that the mechanisms for co-creation and co-evolution between universities and industry are underdeveloped, leading to a fragmented and less synergistic relationship. Consequently, knowledge generated in universities may not be effectively translated into industrial application, and industry demands may not adequately shape academic research agendas.

Furthermore, the substantial lack of formal R&D policies (70%) within industrial organizations, while an internal industry issue, implicitly points to a less influential "government" helix. In a mature Triple Helix, government policies and institutional frameworks would actively incentivize and potentially mandate such formalization, thereby creating an enabling environment for structured and sustainable collaborations. The current scenario suggests that the policy and regulatory environment has not yet fully catalyzed the necessary internal organizational changes within industries to optimize their engagement with academia.

4.2.2. Institutional theory: Explaining organizational behavior and formalization

Institutional Theory provides a valuable framework for understanding why organizations conform to—or deviate from—certain norms and rules, offering insights into issues like the absence of formal R&D policies [36, 37]. This theory sheds light on both the lack of formal R&D policies and the persistence of communication gaps observed in collaborations.

Specifically, the widespread absence of formal R&D policies in many industries can be attributed to institutional isomorphism. If the prevailing norm within the Nigerian industrial landscape is one of informal or ad-hoc engagement with R&D, companies may not experience sufficient coercive pressure. This pressure typically comes from strong government mandates or significant penalties for non-compliance. Similarly, they may lack mimetic pressure, which would involve imitating leading firms that have successfully formalized their R&D processes. Furthermore, normative pressures from professional associations or educational bodies might not yet strongly advocate for formalized R&D structures as a standard best practice for collaborative innovation. This suggests that the institutional environment in

Nigeria may not adequately incentivize or demand such formalization, contributing to the observed inconsistencies in collaborative efforts.

Moreover, persistent communication gaps and misalignments can also be analyzed through an institutional lens. If formal mechanisms for university-industry dialogue—such as joint committees or clear intellectual property policies—are not institutionalized as routine and legitimate ways of operating, interactions will likely remain sporadic and unstructured. The absence of these ingrained routines makes it difficult to overcome the natural barriers between distinct organizational cultures, particularly those separating academia from industry.

4.2.3. Human capital theory: Understanding talent and skill dynamics

Human Capital Theory emphasizes the value of investing in individuals' skills and education, and how these investments contribute to economic productivity [38, 39]. This theory helps us understand the incentives for collaboration and the skill gaps often found among graduates. Industries' primary motivations for collaborating with universities—identifying future employees and gaining access to innovative ideas—are direct applications of Human Capital Theory. Businesses recognize universities as crucial sources of human capital (skilled graduates) and intellectual capital (innovative ideas from researchers). Their engagement is an investment aimed at securing a pipeline of productive talent and leveraging external knowledge to enhance their own research and development (R&D) and overall competitiveness.

However, the reported critical deficiencies in student research capabilities, such as issues with data analysis, practical experience, and communication, pose a significant challenge to effectively utilizing this human capital. This suggests that the current university "investment" in human capital development may not be yielding optimal "returns" for the industrial labor market. The mismatch indicates that the skills being produced aren't fully aligned with industry demands, leading to inefficiencies in talent acquisition and potentially higher training costs for industries. This highlights a clear need for greater collaboration between universities and industries to ensure that human capital development is demand-driven and produces graduates with immediately applicable skills.

4.3. Discussion in Terms of Broader Implications for National Development

The results from the needs assessment survey carry profound implications for national development in Nigeria, extending beyond the immediate scope of individual university or company engagements. They highlight critical strengths and weaknesses within Nigeria’s innovation ecosystem that directly impact its global competitiveness and capacity for sustainable growth.

Firstly, the findings reveal a significant asset: the strong interest from industries in collaborating with Nigerian universities, coupled with the fact that 100% of industrial sector respondents reported active collaborations on research projects. This prevalent engagement, observed across diverse sectors such as engineering, power generation, technology, and oil & gas, indicates robust underlying potential for fostering innovation and addressing real-world challenges crucial for national growth. By strategically aligning university research with the pressing needs of these key industries, Nigeria stands to significantly accelerate its economic development and enhance its competitive edge in both regional and global markets. This existing foundation of collaboration, even if informal, presents a powerful leverage point for future initiatives.

Secondly, the identified systemic challenges, particularly the persistent communication gaps (cited by 91.7% of respondents) and the misalignment between university research outputs and industry needs, represent critical hurdles to national progress [7,8,33]. If left unaddressed, these issues will perpetuate a debilitating disconnect between academic intellectual capital and practical industrial application. This hinders the effective translation of research into tangible solutions for national problems, such as energy security, infrastructure development, or technological advancement. Strengthening communication channels, for instance, through the establishment of dedicated liaison offices, and ensuring research relevance by co-creating research agendas with industry stakeholders, are vital steps. Such measures will ensure that academic endeavors directly contribute to national progress by producing demand-driven research outcomes.

Thirdly, the findings report underscores significant skill deficiencies among university graduates, particularly in foundational areas such as data analysis, literature review, research question formulation, and effective communication [27,28]. These gaps are likely to directly compromise the quality of Nigeria's future workforce and their capacity to contribute meaningfully to industry and research. Addressing these critical skill deficiencies through targeted training programs, enhanced practical exposure, and applied learning methodologies is paramount. Equipping graduates with

in-demand skills will not only improve their employability but also empower them to drive innovation, meet the evolving demands of a developing economy, and ultimately enhance national development.

It could be summed up from the foregoing discussion that Nigeria's university-industry collaborative ecosystem is dynamic yet underdeveloped. The Triple Helix Model highlights systemic gaps in communication and policy influence, while Institutional Theory explains the persistence of informal R&D practices, with 70% of surveyed organizations lacking formal R&D policies. This informality undermines trust and mutual benefit. Human Capital Theory pinpoints a critical disconnect in skill development, hampering the effective flow of talent. Addressing these challenges requires fostering individual collaborations through systemic changes that reinforce communication, formalize institutional practices, and strategically align human capital development with national industrial needs. This will enhance Nigeria's innovation capacity, contributing to job creation, technological advancement, and large-scale problem-solving relevant to local challenges.

4.4. Study Contributions, Limitations, and Future Research

This study significantly contributes to understanding university-industry collaboration for student research in Nigeria, a context often under-researched. By gathering direct input from diverse industrial sectors and highlighting specific quantitative measures of challenges (e.g., 91.7% communication gap, 70% lack of R&D policies), it offers a clear and granular understanding of both opportunities and systemic barriers. The findings provide robust evidence for policymakers, university administrators, industry leaders, and educators, guiding the design of targeted interventions to foster more impactful and sustainable partnerships. This can drive national innovation and enhance graduate employability.

Despite its valuable insights, this study has limitations. It focused on only three selected public universities, meaning the results may not be fully generalizable to all Nigerian institutions. The sampling method for industrial participants was not very detailed with less than 100 respondents, making it difficult to gauge the sample's representativeness. Additionally, while collaboration was reported, its depth and specific nature were not fully explored. Finally, the study primarily gathered industry perspectives, lacking crucial insights from university academics and administrators, which would provide a more complete picture.

4.5. Recommendation for Reform and Alignment

Based on the key findings from the survey, the following actionable recommendations are proposed to bridge identified gaps and unlock the full potential of university-industry collaboration for engineering student research in Nigeria:

- Enhance Communication and Coordination Mechanisms: Formal platforms, such as joint liaison offices or online portals, should be established to enhance continuous communication, project matching, and feedback. Regular "Industry-Academia Forums" should be organized, and clear communication protocols with designated contacts developed.
- Align University Research with Industry Needs: University research should be aligned with industry needs by forming industry advisory boards to guide curriculum and research focus. Mechanisms for industries to submit research challenges, creating student project opportunities, should be implemented, and standardized intellectual property (IP) frameworks developed to streamline collaboration.
- Promote Formal R&D Policy Development in Industries: Industrial organizations, particularly SMEs, should be encouraged and supported in developing formal R&D policies; government agencies and industry associations should disseminate best practice guides and offer incentives for companies adopting these policies, alongside facilitating workshops on their benefits.
- Address Student Skill Gaps: University curricula should be revamped to address student skill gaps, integrating practical training in data analysis and emphasizing project-based learning. Internships should be mandated, and compulsory workshops on scientific writing and professional communication implemented.
- Leverage Incentives for Deeper Engagement: Existing incentives should be maximized and new ones explored to deepen partnerships, including highlighting successful case studies and government/professional bodies exploring additional tax benefits, grants, or co-funding for joint research projects. Formal recognition programs for exemplary collaborative efforts should also be developed.

By systematically implementing these recommendations, Nigeria can foster a more integrated, impactful, and sustainable ecosystem for university-industry collaboration, ultimately accelerating innovation, enhancing graduate employability, and contributing to national development.

5. Conclusion

The needs assessment survey provides a crucial snapshot of the current state of university-industry collaboration for engineering student research in Nigeria. It unequivocally highlights both the strong potential and the significant systemic barriers within this critical interface. From the foregoing, the following can be concluded:

- The study reveals a universal willingness (100% of industrial respondents) from Nigerian industries to collaborate with public universities on student research projects. This engagement is primarily driven by strategic incentives such as the desire to identify future employees and gain access to innovative ideas, indicating a recognized value in academic partnerships.
- Despite the high engagement, significant challenges persist, most notably widespread communication and coordination gaps (91.7% of respondents) and a notable misalignment between university research priorities and industry needs. This is further compounded by a lack of formal R&D policies within many industrial organizations, leading to ad-hoc and less impactful collaborations.
- The assessment highlights significant deficiencies in key research skills among students, particularly in areas like data analysis, interpretation, and research formulation. This mismatch between academic training and industrial requirements directly impacts student employability and their effective contribution to industry-relevant projects.

Overall, the university-industry collaborative ecosystem in Nigeria is characterized by fragmentation, informality, and a lack of strategic alignment. While there's a clear desire for collaboration, the absence of robust frameworks and a less influential role of the "government" helix prevent the optimal leveraging of academic and industrial resources for national development and innovation.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors have declared that no competing interests exist.

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