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Academic Spin-Off in Nigeria with an Energy Kiosk as an Illustrative: A Literature Review

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Abstract:- Energy access is a critical determinant of socio-economic development and quality of life. While energy kiosks have emerged as a potent solution for extending energy access to underserved communities, their development often necessitates innovation and expertise that academic institutions can offer. By facilitating knowledge transfer and leveraging intellectual capital, academic spin-offs play a pivotal role in accelerating progress toward universal energy access. Energy kiosks, also known as energy access points or mini-grids, have emerged as a critical solution to address the energy access gap in underserved and remote communities. These kiosks play a pivotal role in providing clean and reliable energy services to off-grid areas, improving the living standards. This paper provides an overview of the intersection between Academic Spin-Offs (ASO), (which are startups or companies originating from academic research), and the development of energy kiosks based on works from a selected number of journals.

Keywords: *Academic Spin-off, Energy Kiosk, High-Tech Spin Off Companies, Virtual Power Plant.*

I. INTRODUCTION

The landscape of higher education has undergone significant changes in recent decades, placing a renewed focus on applying academic research in practical ways that benefit industries. In this dynamic setting, the concept of Academic Spin-off has emerged as a promising means of connecting academia with the business world. These entrepreneurial initiatives, originating from the creativity and inventiveness of academics, have gained considerable attention for their potential to transform cutting-edge research into commercially viable ventures and promote socio-economic development. Academic Spin-offs play a vital role in transferring knowledge by turning intellectual capital into tangible results. Through the commercialization of scientific breakthroughs, technological advancements, and innovative concepts, these spin-off ventures stimulate economic growth, create jobs, and have a positive impact on society [1]. They embody researchers' desires to see their discoveries put into practical use, encouraging innovation and entrepreneurship within educational institutions.

Accessing clean and dependable energy is a fundamental requirement for human development and economic advancement. Nevertheless, a significant number of people worldwide, particularly those in remote and off-grid areas, still lack access to electricity. Energy kiosks have emerged as a promising solution to bridge this energy access gap. These small-scale energy distribution points typically rely on renewable energy sources like solar and wind power and serve as a vital resource for communities without access to the traditional power grid. The effective establishment and operation of energy kiosks depend on the collaboration and coordination among various stakeholders. By offering a comprehensive overview of academic spin-offs, we aim to provide researchers, educators, policymakers, and industry professionals with insights into how these initiatives can reshape the academic landscape.

This paper aims to make a meaningful addition to the existing body of knowledge concerning academic spin-offs. By involving a wide range of perspectives from scholars, practitioners, and policy-makers, we ensure a comprehensive exploration of this dynamic field. Our hope is that the insights presented in this paper will not only inspire further research but also serve as a catalyst for advancements in the collaboration between academia and industry, creating an environment conducive to knowledge-based entrepreneurship. The realm of academic spin-offs possesses significant potential for leveraging the intellectual capital generated within educational institutions. By offering a pathway to turn ideas into sustainable and impactful ventures, these spin-offs stimulate economic growth, drive technological progress, and nurture an atmosphere of innovation. This resource will be invaluable for individuals interested in comprehending and harnessing the potential of academic spin-offs to facilitate knowledge transfer and promote entrepreneurship in the realm of education.evacare.

II. ACADEMIC SPIN-OFF PROCESS

There exist businesses established specifically to take advantage of the outcomes of research conducted by higher educational institutions and these are called Academic Spin-offs (ASO). These companies offer considerable potential to generate wealth through the commercialization of such research. However, unlike other new high-tech startups, such firms encounter additional environmental obstacles [2]. The political-economic setting surrounding higher

education, whether on a worldwide, regional, national, or local scale, is undergoing transformations. Education is being restructured, leading to a redefinition of curriculum development, research, and service. These are referred to as the increase of academic capitalism, supply-side higher education, and the management of professionals focused on economic competitiveness [3].

To establish a spin-off, there is a requirement for the transfer of certain rights, such as knowledge, from the current organization to the new company. Spin-offs can be categorized based on the source organization they originate from and the entrepreneurial background of the founders. Academic spin-offs primarily emerge due to technological advancements rather than a presumed competitive advantage in marketing, sales, or distribution. The founders typically consist of engineers and scientists, sometimes complemented by individuals with marketing, sales, or business experience within the founding team. Not all academic entrepreneurs necessarily have unique ideas or a strong drive for achievement; some may initially seek greater independence or experience a level of dissatisfaction [4]. When comparing the personal motivations of founders in spin-off and non-spin-off companies, the desire for the freedom to explore new ideas is often more common than testing one's entrepreneurial abilities [5]. This aspect will play a pivotal role in the development of our Energy Kiosk. The motivation to advance existing technology has been the primary driving force behind this Academic Spin-Off (ASO). The results derived from customer experiences and data will be crucial in making necessary adjustments to create a viable technology that would be a source of pride for the institution. Founders of well-established companies typically start with a strong orientation toward engineering and technology, with a shift toward marketing occurring gradually over time, assuming the company survives.

Roberts [6] identified four primary entities involved in the spin-off process:

- The technology originator, which can be an individual or organization responsible for advancing technology from fundamental research through the various stages of innovation and development, reaching a point where technology transfer becomes feasible.
- The parent organization where the technology originator conducts research and development (R&D).
- The entrepreneur or entrepreneurs who take the technology developed by the originator, sometimes including the originator themselves, and endeavor to establish a new business venture centered around that technology.
- The venture investor who provides financial support to the new company, often in exchange for partial equity ownership or a share of sales revenue generated by the new venture.

Meanwhile, Pattnaik [7] highlighted five entities which are;

- Research
- Entrepreneurial commitment
- Threshold of credibility
- Threshold of sustainability
- Sustainable returns

However, as more work has been done, these primary entities can now be grouped into; Technology, Infrastructure, Finance and Community Engagement.

III. METHODOLOGY

A comprehensive search across INFORM and Science Direct platforms using specific keywords. Since these databases do not cover the same journals, we needed to cast a wide net. Following each search query, we manually examined the abstracts to identify relevant articles. Additionally, we conducted a reference search within each relevant article to uncover any published materials not present in the databases.

After this thorough screening process, we refined the initial pool of over 122 papers to a selection of 25 that contained information on spinouts. These 25 papers were categorized into two groups: spinout literature and energy kiosks literature. The spinout literature comprised 17 papers dedicated to the study of the spinout phenomenon, both conceptually and empirically as well as insights on technology transfer and New Technology Based Firms. Meanwhile, that of Energy Kiosks comprised only of 8 papers.

[8] classified his literature into three clusters based on the level of analysis: macro, meso, and micro levels. Macro-level studies delved into the macroeconomic context of spinouts, examining the government and industry's roles in the spinout process. Researchers scrutinized spinout-related policies, support mechanisms, the regional economic impact of spinouts, and industry and market conditions conducive to spinout success. Meso-level studies centered on universities and Technology Transfer Offices (TTOs), aiming to identify support mechanisms employed by academic institutions to encourage spinout creation and assess the effectiveness of spinning out as a university technology transfer strategy. Micro-level studies focused on the individual firms and entrepreneurs involved in the spinout process. This is the system we also used for our classification.

IV. MACRO LEVEL STUDIES

➢ *Government Roles in Academic Spin-Off Process*

The shift from Research Academic Institutions to Entrepreneurial Academic Institutions have been examined [9], as academia has begun to adopt entrepreneurial practices both internally and externally, such as collaborating with businesses for research and knowledge sharing. It is widely acknowledged that the current government funding for Nigerian Higher Institutions is insufficient, which has resulted in a stagnation in the development of such institutions [10]. Thus, there is a need to focus on generating revenue within the institutions themselves, known as Internally Generated Revenue (IGR),

which can be attained through Academic Spin-offs. IGR is the revenue that Institutions generate within the areas of their jurisdiction. The importance of generating internal revenue (IGR) was emphasized in relation to Makerere University in Uganda's reliance on government funding [11]. Prior to 1990, the university was fully funded by the government, but insufficient funds led to a decline in the quality of the university and the departure of educated personnel. Despite being unwilling to introduce cost sharing because it was politically unpopular, the government was unable to provide for the university's needs. In recent years, research has been conducted to understand the value of ASO. One study, which involved examining a range of cases, found that ASO progressed through various phases of development, each requiring the venture to meet certain critical junctures while also engaging in an iterative, non-linear process [2]. Adherence to sustainability reporting practices is required during these transitional stages. This is a tool that businesses can use to assess their environmental, social, and economic efficiency, and its absence creates a significant disconnect between the company and its customers, impacting its return on equity [12]. In [13], various methods were explored for universities to manage the commercialization of intellectual property, including using equity to generate income and align the interests of faculty, industries, and institutions. Ajayi, [9] used a descriptive survey design and Pearson Product Moment Correlation to investigate additional sources of revenue for IGR. Onuoha, [14] delved into how IGR plays an integral role in funding higher education in Nigeria. A census sampling approach was used to access the management and sustainability of IGR in Nigerian Institutions [15]. In [16], the importance of academic libraries in Nigeria advertising their information products and services to generate additional revenue for their respective institutions was emphasized. It is crucial to improve IGR in Nigerian Educational Institutions, and the most effective way to do so is through the establishment of High-Tech Spin-Off companies.

V. MESO LEVEL STUDIES

The technological progress has acted as the primary reason for the difference in growth rates between Western nations and African countries. The introduction and marketing of technology globally have enabled wealth transfer from the underdeveloped African nations to the prosperous Western societies. Meanwhile, these Western societies seek skilled labour from the African countries to further enhance their technological advancements, resulting in a continuous economic collapse in Africa. Therefore, it is vital to comprehend the impact of technology development on IGR growth. The Faculty of Engineering, particularly the Department of Electrical and Electronics Engineering, plays a pivotal role in researching modern technological advancements. Academic involvement in innovation creation is not motivated by an entrepreneurial attitude, but instead by the hope of achieving better academic status. The primary incentives for academics are the availability of technologies with commercialization potential, access to institutional infrastructure, and personal benefits. The current scarcity of resources in our institutions is hindering the perception of aid towards ASO as a supplementary motivation [17]. The electronics and software development companies' innovative performance was determined to be influenced by several internal and external factors through statistical analysis. Of the internal factors, the possession of scientific experience was highlighted as significant [18]. Hence, the significance of the Electrical and Electronics Engineering department in establishing these ASOs is underscored. The organizational abilities of academic spin-off companies in emerging industries were influenced by the research communities from which they originated [19]. The level to which University-Level Support Mechanisms (ULSMs) and Local Context Support Mechanisms (LCSMs) work together or take the place of each other in promoting the formation of academic spin-offs was also analysed in [20].

The negative effects of using fossil fuels have increased the importance of renewable energy sources, which have the potential to grow and improve [21]. For various reasons, a decentralized approach based on local renewable energy sources is being recognized as a viable option for remote areas [22]. To address this issue, we will consider the development of an Energy Kiosk (EK) in order to highlight the role the Department of Electrical and Electronics Engineering at Rufus Giwa Polytechnic, Owo has to play in the formation of ASO. This EK is a solar-powered structure with multiple charging outlets that would help students keep their devices powered. As the cost of electricity continues to rise and the Institution faces a huge task of provision of constant electricity, many students are struggling to power up their devices, leading to dependence on friends off-campus. This represents a key opportunity as these EKs can solve this issue. However, the EKs would provide a cost-effective solution by allowing students to pay a small fee for a full battery charge. This would generate additional revenue for the school as well as provide a vital method for supplying electricity to remote regions with inadequate power supply. As a result, a lot of research has gone into developing the EK system.

VI. MICRO LEVEL STUDIES

An evolutionary standpoint was utilized in [23] to explore the origins of resources that contribute to defining these skills and elucidating their developmental trajectories. In their investigation, they pinpointed three critical competencies: opportunity refinement, resource leveraging, and advocacy, which played a pivotal role in establishing credibility for these ventures. [24] offered a fresh perspective on the establishment and growth of network connections in the context of developing entrepreneurial skills for university spin-offs. Their integration of competency theory and network theory has unveiled that the utilization of both strong and weak network connections depends on the particular competency being pursued and the stages of venture development. They also introduced a framework that elucidates how academic entrepreneurs not

only create specific network ties to cultivate particular competencies but also adapt existing connections for different purposes.

Renewable energy, particularly solar power, is currently a highly lucrative field for investors seeking to make large profits from smart investments in clean energy [25]. Elsherbini, [26] utilized two solar cells to convert and store light energy into both direct and alternating current for charging and powering various electrical devices. The charging station and hardware system were closely monitored throughout the process. Additionally, a prototype mobile charging station with a fingerprint security system was developed in [27], which issues a warning and prevents access to unauthorized users with unrecorded or mismatched fingerprints. Munro [28], examined a social enterprise for its potential to address the financial challenges of expanding grid electricity networks into underdeveloped rural areas. A comprehensive evaluative framework was developed in [29], which took into account factors such as long-term commercial viability and positive community impacts to assess the outcomes of the social enterprise. A structure was established to assess an NGO's EK program in Sierra Leone, West Africa critically. The individuals involved in this project [30, 31] were responsible for the development of the Virtual Power Plant (VPP), which seeks to reduce electricity usage and increase the effectiveness of renewable energy sources. This VPP manages and combines various energy resources including Solar PV generators, Energy Storage, and gas generators to ensure energy conservation and profit maximization. To optimize the VPP's weekly self-scheduling, the team implemented a conventional power plant and a storage system, which included intermittent renewable sources. Additionally, they utilized the Information Gap Design Theory (IGDT) to model the uncertainties in the market and enhance the VPP's overall profit [32].

VII. DIRECTIONS FOR FURTHER RESEARCH AND CONCLUSION

Certainly, exploring the realm of academic spin-offs is a dynamic and evolving field of study with significant implications for innovation, entrepreneurship, and academia itself. As we stand at the intersection of academia and industry, it becomes increasingly important to outline the directions for further research in this domain. Here, we highlight several promising avenues for future research on academic spin-offs:

Firstly, we should consider delving deeper into the broader entrepreneurial ecosystems where academic spin-offs operate. Explore how factors like government policies, local industry clusters, and support networks impact their success. It has also become important to understand the role of interdisciplinary collaboration in academic spin-offs. How partnerships between different academic disciplines contribute to innovation and competitiveness. Cross-national studies should be conducted to compare the development and success of academic spin-offs in different countries. This can help identify best practices and contextual factors influencing their growth.

The long-term performance and sustainability of academic spin-offs has not been examined. We do need to understand how they evolve beyond the initial stages, and what factors contribute to their continued growth or decline. This will lead us to know the funding challenges and opportunities for academic spin-offs, including the effectiveness of various funding mechanisms, such as venture capital, government grants, and corporate partnerships. Thus, the role of Technology Transfer Offices in facilitating the commercialization of academic research and their effectiveness in supporting spin-off creation will be influenced. Spin-off is a specific method, though not necessarily the most significant one, for carrying out technology transfer. However, spin-offs serve as a potential avenue for academic institutions to transfer technology, especially as they increasingly aim to contribute to the economic growth of their regions. Academic spin-offs represent a dynamic and innovative bridge between the world of academia and the realm of entrepreneurship. They are vehicles through which the intellectual capital generated within educational institutions is translated into tangible and impactful venture.

On the social front, the environmental impact of academic spin-offs is an important consideration for future work. This is because they have a direct impact on job creation, innovation and many more. Meanwhile, Academic Spin-off is influenced by ethical and legal issues, such as intellectual property rights, conflicts of interest, and responsible research and innovation practices.

By exploring these research directions, scholars can contribute to a deeper understanding of academic spin-offs and their role in driving innovation, economic growth, and societal progress. Understanding the roles and responsibilities of each entity is crucial for policymakers, investors, and development practitioners seeking to address the energy access gap. By fostering an integrated approach that encompasses these four entities, energy kiosks can become a catalyst for positive change, improving living standards, stimulating economic development, and advancing the global goal of universal energy access.

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