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The Development of Technology Parks around Engineering Faculties Managed by Professionals, Lecturers and Students: Enhancing Engineering Skills, Innovation, and Self-Reliance to Drive Rapid Industrialization in Nigeria

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ABSTRACT: Nigerian has been faced with a lot of challenges like insecurity, high rate of inflations and continual devaluation of Naira. These issues have greatly affected different multinational companies operating in Nigeria as high inflation and insecurity have resulted in these companies continuing to incur losses every year. Most of the companies have moved their production to other African countries that have favorable policies and a safe environment. Nigeria is gradually transforming into a consumer nation, totally dependent on imports of different commodities, with the Naira continuously depreciating and inflation rising, leading to high unemployment among Nigerian engineering graduates. This paper explores the establishment of technology parks around engineering faculties in Nigerian universities, managed by professionals, lecturers and students, as a strategy to enhance engineering skills, foster innovation, promote self-reliance among graduates and increase the entrepreneurship skills of engineering students to help in technological advancement of Nigeria. By reviewing existing literature, analyzing case studies, and conducting interviews with key stakeholders, the study identifies the potential benefits and challenges associated with this approach. Pareto Analysis prioritize the factors necessary to set up technology part and the results show that. Funding and Investment (13%), Government Support (12%), Infrastructure Development (12%), Industry Collaboration (11%), Skill Development (10%), Management and Governance (10%), Research and Innovation (9%) have an overall impact of 77.89% in developing and managing technology park around engineering faculties. Again, the proposed model integrates practical training, research, and entrepreneurship in technology parks to create a conducive environment for innovation and skill development. The findings highlight the critical role of government support, industry partnerships, and academic leadership in the successful implementation of technology parks. This paper concludes with recommendations for policy makers, educational institutions, and industry stakeholders to collaborate in driving Nigeria's industrialization through enhanced engineering education and innovation.

KEY WORDS: higher education, Science Park, Technology Park, innovation area, university companies, national and regional development, national innovation system

INTRODUCTION

1.0 Background

Nigeria's pursuit of swift industrialization and enduring economic growth, prompted by elevated rates of inflation, unemployment, insecurity, and Naira depreciation, has underscored the necessity for a resilient engineering education system that generates graduates endowed with pragmatic competencies, inventive aptitudes, and an entrepreneurial spirit. The heavily theoretical nature of traditional engineering curricula prevents students from gaining the skills necessary to succeed in a fast-paced industrial setting. A potential way to close this gap is the creation of technology parks surrounded by engineering faculties, overseen by experts, educators, and students. The transition to a knowledge-based economy is a clear example of the global approach in action today. The term "knowledge-based economy," which has been highlighted in national development strategies by the Organization for Economic Cooperation and Development (OECD), refers to the role that knowledge and technology play in economic development. To advance and achieve sustainable economic development, nations must foster innovation and technological advancement. Various mechanisms have been considered in this regard, including university science and technology parks. Put another way, the creation of science and technology parks is regarded as one of the fundamental ways to foster an innovative culture and the expansion of knowledge-based enterprises in nations where economic development is predicated on the promotion of innovation and technology as well as the commercialization of cutting-edge technologies. It is clear that science and technology parks play a vital role in the innovation infrastructure that supports initiatives like technology transfer, research commercialization, participation attraction, and risk mitigation for start-up enterprises. Technology parks serve as a bridge between academia and business, helping to

identify industry research needs and transforming university potential into real-world applied research projects. The purpose of this study was to look into University Technology Park's role in advancing engineering development. The experience of Nigerians in technology and innovation, as well as the contributing elements to Nigeria Technology Park's success, were investigated to delve deeper into the topic. Building smart infrastructures within the national innovation system is one of the key success factors in the transition to a knowledge-based economy. One of the most important parts of the national innovation system and the bridge that connects academic institutions and businesses abroad are technology parks. They are thought to be a useful tool for fostering innovation and growing new companies. The purpose of this study was to determine the impact of developing technology parks around campuses on the innovative intelligent quotients of engineering students and the advancement of technology. The analysis of China's science and technology sectors indicated that the University Technology Park was a useful location for investigating China's relationships with the Chinese government, universities, and industry. The Chinese government has been pushing science and technology toward the market since the 1980s and has created new regulations to diversify university funding sources. It was successful in making a major economic advancement thanks to government support for higher education and the execution of focused plans and programs, such as the creation of science and technology parks and the promotion and support of innovation and technology. One of the main objectives of creating a university science park was to encourage the commercialization of university technology and provide a space for the management of university spin-off companies.

The findings showed that the following elements affect technology park performance in China: infrastructure, stakeholders, governance and management of the park, scientific and economic innovation environment, and government support. Studies show that one of the key success factors for science and technology parks is offering the right services to the companies that operate there, enabling them to successfully enter national, regional, and international markets. It also helps students learn real-world knowledge and share creative ideas, all of which will contribute to the rapid advancement of engineering in Nigeria. Universities should therefore make an effort to draw in creative and enterprising faculty members by offering the proper resources, infrastructure, and assistance. Innovative and start-up businesses can be encouraged to locate in university technology parks by providing clear and encouraging regulations and laws. Particular focus should be placed on developing appropriate, encouraging, and supporting platforms for the transition from idea to commercialization and technology transfer. During the 1980s, Technology Parks became an increasingly popular phenomenon. These days, this concept has given rise to numerous spin-offs, the most widely used of which are Science Parks, Industrial Parks, Knowledge Parks, and Business Incubators. All of these spin-offs were established with the same goal in mind: by fusing knowledge and business, they hope to boost economic growth within the local cluster and eventually across the country. Technology Parks encourage generation and facilitate more effective knowledge transmission and sharing by combining these knowledge-based activities. Especially in the situation of Nigeria, where unemployment rate among university graduates are very high it is crucial to transform from a primarily theoretical based framework into a knowledge-practical based economy in order to make graduated students self-reliance and help them to engage in start-up companies that will drive technological advancement of Nigeria. Another spin-off similarity is the triangular structure, also known as the Triple Helix philosophy; including government, private companies and knowledge institutes which are the actors of innovation but in this case university should own and manage the companies by the expertise, lecturers and students to drive engineering development and self-reliance of students after graduation. According to the research, startups (less than five years old) create significantly more jobs than larger businesses, which aim to cut costs by hiring fewer people and producing more goods at a lower cost of production. As a result, Nigerian engineering students who join new businesses after graduation will boost the country's engineering industry and generate jobs. For instance, start-ups create 3 million jobs annually on average in the USA. They also convert cutting-edge concepts and academic understanding into a business strategy or model. Technology Parks commercialize the research that is conducted there by doing this. They produce new goods and services that increase the net wealth of society (Multimedia, 2012).Technology Parks bring in skilled labor, investments, and international students in addition to fostering job growth and job creation in the area. A large pool of technical talent, the availability of pre-existing infrastructure and a large network of suppliers, access to venture capital, access to top-notch research and educational facilities, and well-developed information networks are some competitive advantages that help the creation of new firms (Koh, Koh, & Tschang, 2003). Additionally, some governments anticipated that Parks' technology (Koh, Koh, & Tschang, 2003) would aid in: 1. "Promotion of industrial research and development (R&D) to raise the technological advancement of local industries." 2. Encourage foreign investment, particularly in higher-valued industries 3. Quicken the shift in the economy from one that is labor-intensive to one that is knowledge-

intensive. Moreover, a technology park is a distinguished "premium brand." It provides tenants and their goods with a recognizable brand, an enhanced and prestigious image. Attracting clients, partners, vendors, staff, and the media gets simpler. This gives small and medium-sized businesses significant leverage. (2011) Molina, Aguirre, Breceda, and Cambero. A further advantage that businesses may experience is having easy access to nearby potential business partners. (Tschang, Koh, & Koh, 2003). In many nations, the necessity for socioeconomic development has led to the creation of technology parks. Literature claims that they frequently serve as a catalyst for regional economic development..

Technology parks have four main objectives: to boost wealth, to encourage a knowledge-practice based economy, to encourage an entrepreneurial culture, and to boost competitiveness. They also, among other things, improve technological capability, raise venture capital, improve employment quality, add high value to the regional economy, and create jobs. The question is, do they incite these improvements, and if so, how can this be measured? This is crucial for modifying and enhancing the results of Technology Parks. Furthermore, information about performance and prospects for the future is important for stakeholders, financial sponsors, and possible funders.

1.1 Objectives

The primary objectives of this study are to:

1. Examine the concept and benefits of technology parks in the context of engineering education.
2. Analyze successful models of university-based technology parks globally.
3. Identify the challenges and opportunities in establishing technology parks in Nigerian universities.
4. Propose a framework for the development and management of technology parks around engineering faculties in Nigeria.
5. Provide recommendations for stakeholders to support the implementation and sustainability of technology parks.

2.0 LITERATURE REVIEW

2.1 Theoretical Framework to assess the development of Technology Parks

The study's theoretical framework is based on the ideas of innovation ecosystems, experiential learning, and entrepreneurship education. The value of real-world, hands-on experiences in education is emphasized by experiential learning (Kolb, 1984). The cooperative networks of organizations, companies, and governmental bodies that promote innovation are highlighted by innovation ecosystems (Jackson, 2011). The main goal of entrepreneurship education is to help students acquire the abilities and mindset required for successful entrepreneurship (Kuratko, 2005). Framework for assessment An evaluation framework for technology incubators as well as some examples of particular indicators were developed by Chan and Lau in 2004. Chan and Lau (2004) Pooling resources, planning staff development activities, marketing events, exhibitions, press conferences, sharing laboratory facilities, office equipment, testing equipment, administrative support (such as meeting rooms, libraries, and reception areas), and consulting/counseling services are among the criteria for evaluating particular indicators**..** The public perception of the government networking, science park, and university Access to customers, suppliers, and subcontractors; chances for collaboration with other tech companies in the incubator; sharing and dissemination of knowledge; clustering the creation of a skilled labor pool; externalities resulting from logistics arrangements; externalities resulting from supporting networks (e.g. emergence of complementary industry) geographic closeness, market accessibility, research facility, university rental subsidies, telecom/computer network access subsidies, and additional cost-cutting measures

2.2 Performance Matrix

A matrix of key performance indicators was created during the International Association of Science Parks and Areas of Innovation (IASP) workshop on assessing the success of science and technology parks (Manchester, 2010). Participants first deliberated and reached a consensus on "what a successful technology park means to different stakeholder." As a result, they recorded a number of elements from the viewpoints of various stakeholders. They then gave each aspect a priority and developed metrics to track advancement in those areas. A performance matrix was created using those metrics. The new performance model that will be created for the institution's Technology Parks may find the structure of the performance matrix to be interesting (Dabrownska, 2011).

2.3 Method

In order to determine which campuses are of national interest, Buck Consultants International conducted research on the possibility of stimulating campuses having economic surplus value in 2009. Their analysis shows that a successful campus excels in the four main areas of talent, money, technology, and connectivity. Figure 1 illustrates these components and their relationships. Putting campuses into four distinct stages with varying maturities is the first step in figuring out if they are of national importance. Several features allow for the differentiation of the various campus types. The four phases are as follows: • Idea stage: project is in the feasibility/exploration stage; • Startup stage: physical environment is realized; • Growth stage: campus expands with more businesses and researchers**.**

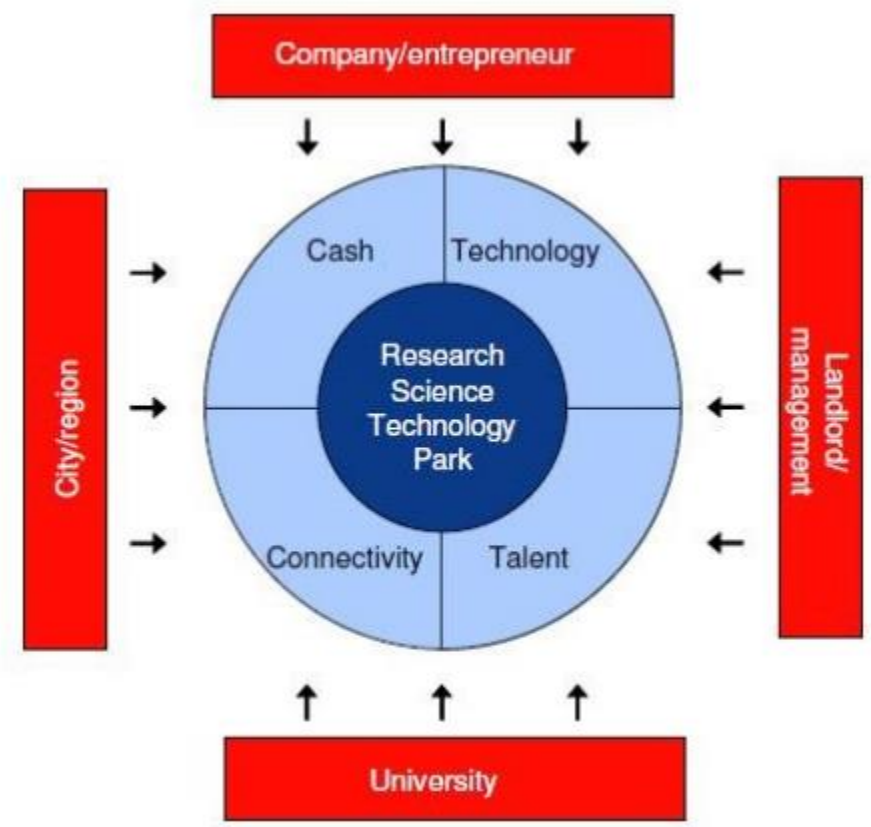


Figure 1: Important factors for a successful campus (Buck Consultants International, 2009)

2.4 Global Perspectives on University-Based Technology Parks

Nigeria currently lacks knowledge and experience regarding international standards and best practices for technology parks. The institution's management is interested in learning more about the motivations and forces behind Technology Parks as well as their possible consequences. The management of the organization is interested in learning about the factors that propel innovation and how Technology Parks impact technological innovation, assuming that one of the results of Technology Parks is rapidly expanding innovation. Is student practical skill, product and process innovation knowledge, and university participation in a Technology Park company being stimulated by cooperation and collaboration between universities and enterprises? Or does their input amount to nothing? This is significant because competitiveness is largely dependent on innovation. (OECD, 2007). It is critical for the country of Nigeria to be able to compete with other emerging economies, as background studies have indicated. In addition to fostering innovation, technology parks also help the region create high-value jobs, which is a significant outcome by official accounts. However, there is also a lack of information regarding the types of jobs created, specifically the variations in the educational requirements for the jobs. In parallel with this matter, what kinds of businesses are housed in the Technology Park? If yes, do they presently support students' creativity and, in turn, their competitiveness? The "enterprise-selection" criteria for various Technology Park types do exist at this time; the question is whether or not they are put into practice and whether they are still current. Competitiveness measurement is another dubious topic. Has it previously been measured? Exist any models for quantifying competitiveness and innovation? Are they also applicable to the institution's Parks? Who will pay for the park? This is significant because the government provides funding to businesses and is a key institution in the Technology Park ecosystem.. The way a technology park is set up will likely provide some insight into how well it performs. If it can be demonstrated that the parks contribute to industrialization and the creation of jobs, then the minister of education and technology will fund startups. They do not yet know who can apply or what requirements must be met in order to be eligible for government funding, as this procedure has not been validated. In summary, the issue is that there is insufficient knowledge and experience in Nigeria to determine what qualities the park should have in order to qualify as a technology park. Will the park receive funding? This is

significant since the government is a key player in the technology ecosystem..

The claim that there is significant knowledge transfer is not always supported by the presence of a university or research center in the Technology Park. Sustainability is another factor that needs to be considered. Professionals, students, and lecturers should be involved in manufacturing activities, and manufacturing facilities should be available, in order to make the technology park sustainable. The sustainability of the production process can be greatly impacted by giving the development phase of the product design more thought. Do parks evaluate businesses based on their eco-efficiency and innovation? Do the parks themselves have a corporate responsibility policy? Explanation of the viability of the business plan to be taken into account when creating a technology park near engineering campuses is also required. In the event that a university lacks the necessary research facilities, it may begin by developing businesses and industries that supply some of the goods and services that are typically needed by the campus community. Examples of these include water treatment companies, sewage treatment and cycling plants, plastic molding plants, printing machines, computer design centers, motor diagnostic and repair centers, electroplating rigs, electrical machine repair centers, electrical repair and diagnostics centers, instrumentation and plumbing centers, and architectural and building design centers.. Ultimately, the research will identify some potential success factors of the Technology Park policy and present some recommendations based on the previously mentioned information. In conclusion, some concerns regarding the current Parks are emerging in nations like Nigeria where Technology Parks are still relatively new. First and foremost, Technology Park's name ought to match those who possess the international standards / requirements necessary to be called "Technology Park."

A campus is deemed to be of national interest based on two factors. The region's innovation policy is the first criterion, and economic mass (measured in terms of knowledge workers and R&D activities) is the second. The potential to create the necessary economic mass must be taken into account if the campus (or Technology Park) does not currently have it. According to Technopolis (2009), a campus's primary goals are to promote knowledge exchange and open innovation. However, research from Sweden and Italy also demonstrates that "new technology based firms" in science parks outperform new businesses outside of them in terms of revenue growth, employment growth, the strength of their ties to universities, and the adoption of new technologies. In summary, science and technology parks serve as a national innovation accelerator due to their unique attributes. A successful science or technology park can have a size advantage in the global competition for R&D and knowledge economies. (International Buck Consultants, 2009)

Many nations have successfully established university-based technology parks, which support regional innovation and economic growth. These parks give academic institutions a place to interact with business, advance R&D, and assist in the commercialization of their findings..

1. **Silicon Valley, USA**: Perhaps the most famous example, Silicon Valley, grew around Stanford University and benefited from strong university-industry linkages and a culture of entrepreneurship (Saxenian, 1994).
2. **Tsukuba Science City, Japan**: Tsukuba Science City integrates research institutions, universities, and high-tech companies, fostering collaboration and innovation (Kano, 2000).
3. **Cambridge Science Park, UK**: Managed by Trinity College, Cambridge Science Park is one of the oldest and most successful university-linked technology parks, supporting numerous high-tech startups (Segal Quince Wicksteed, 2000).

2.5 The Concept of Technology Parks around Engineering Facilities

Tech Parks, also known as science parks or research parks, are organizations managed by specialized professionals, lecturers and best students with the aim of increasing the wealth of engineering faculty, creating jobs for students, making students self-reliance after graduation, generate fund for university and bring in international students and finally promoting the culture of innovation and the competitiveness of its associated businesses and knowledge-based institutions. They provides conducive environment for businesses, startups, and research institutions to thrive by offering infrastructure, support services, and opportunities for collaboration.

2.6 Tech Parks around Engineering Campuses in Nigeria

In Nigeria, the concept of Tech Parks is relatively new but may rapidly gaining traction due to the need for technological advancement to create jobs and drive innovations. Countries like South Africa, Kenya, and Rwanda have established Tech Parks that are beginning to show positive impacts on their economies and Nigeria might be considering toeing the part to enhance national development. These parks are tailored to address the unique challenges Nigerian engineering students are facing after graduation due to lack of practical experience and limited infrastructure, funding constraints, and skill gaps.

2.7 The Role of Engineering Faculties

Engineering faculties are crucial in the development and management of Tech Parks. They provide the necessary expertise, research capabilities, and access to a pool of talented students and lecturers. By actively participating in

Tech Parks, engineering faculties can ensure that their curricula remain relevant and aligned with industry needs.

2.8 Case Studies of University-Managed Tech Parks

Several universities around the world have successfully managed Tech Parks, integrating them into their academic framework. Examples include:

- **MIT's Kendall Square**: Known for its vibrant innovation ecosystem, Kendall Square houses numerous startups, research labs, and corporate offices, benefiting from MIT's academic resources.
- **Stanford Research Park**: This park has been a significant driver of Silicon Valley's growth, fostering numerous successful tech companies and startups.
- **Technion-Israel Institute of Technology's R&D Foundation**: This foundation manages multiple tech incubators and accelerators, contributing to Israel's reputation as a "Startup Nation".

3.0 BENEFITS OF TECH PARKS FOR ENGINEERING FACULTIES

Technology parks serve as hubs where academia, industry, and government collaborate to foster innovation, entrepreneurship, and economic development. They provide a conducive environment for research and development (R&D), knowledge transfer, and commercialization of new technologies. By situating these parks within university settings, students and lecturers can directly engage in hands-on projects that bridge the gap between theoretical knowledge and practical application.

1. **Enhanced Learning Opportunities**: Tech Parks provide students with hands-on experience, bridging the gap between theoretical knowledge and practical application.
2. **Research and Development**: They offer faculty members opportunities to engage in cutting-edge research, often in collaboration with industry partners.
3. **Entrepreneurship and Innovation**: These parks foster a culture of innovation and entrepreneurship, encouraging students and faculty to develop and commercialize new technologies.
4. **Industry Collaboration**: Tech Parks facilitate strong ties with industry, ensuring that educational programs are aligned with market needs.
5. **Enhanced Practical Skills**: Technology parks provide students with hands-on experience and exposure to real-world industrial challenges, enhancing their practical skills and employability.
6. **Innovation and Research**: Technology parks foster a culture of innovation and support collaborative research between academia and industry, leading to the development of new technologies and products.
7. **Industry-Academia Collaboration**: Technology parks facilitate strong partnerships between universities and industries, ensuring that academic programs are aligned with industry needs and trends.

3.1 Enhancing Engineering Skills

Integrating technology parks within engineering faculties offers several advantages:

1. **Practical Experience**: Students gain practical experience by working on real-world projects, enhancing their technical skills and employability.
2. **Collaborative Learning**: Collaborative projects involving students, lecturers, and industry professionals promote teamwork, problem-solving, and innovation.
3. **Access to Resources**: Technology parks provide access to advanced equipment, laboratories, and funding, which might be beyond the reach of typical university resources.

3.2 Fostering Innovation

Innovation is crucial for the economic development and industrialization of Nigeria. Technology parks can stimulate innovation through:

1. **Incubation Programs**: Supporting startups and entrepreneurial ventures by providing mentorship, funding, and infrastructure.
2. **Research and Development**: Facilitating cutting-edge research in various engineering fields, leading to new technologies and products.
3. **Industry Collaboration**: Encouraging partnerships between universities and industries to address real-world problems and develop market-driven solutions.

3.4 Promoting Self-Reliance

The development of technology parks can contribute to Nigeria's self-reliance by:

1. **Reducing Brain Drain**: Providing opportunities for talented engineers and researchers to work on impactful projects within the country.
2. **Local Solutions**: Developing technologies tailored to local needs and challenges, reducing dependency on foreign solutions.
3. **Economic Growth**: Creating jobs, supporting local businesses, and fostering a culture of innovation and entrepreneurship

3.5 Challenges in Establishing Tech Parks

1. **Funding and Investment**: Securing initial and ongoing funding can be a significant challenge.

2. **Infrastructure**: Developing the necessary infrastructure requires substantial investment and planning.
3. **Management and Governance**: Effective management and governance structures are crucial for the success of Tech Parks.
4. **Skill Gaps**: Addressing the skill gaps among students and faculty to meet the demands of a tech-driven environment.

3.6 Technology Park in Developing Countries

In developing countries, technology parks have also shown potential in driving economic growth and industrial development. For example:

1. **Technopolis, Malaysia**: Located in Cyberjaya, Technopolis is a collaborative initiative between the government, universities, and industry, focusing on IT and multimedia industries (Khalil, 2000).
2. **Innovation Hub, South Africa**: This technology park supports technology-based startups and innovation through incubation, funding, and networking opportunities (Kaplan, 2010).

3.7 Challenges in the Nigerian Context

Establishing technology parks in Nigerian universities faces several challenges, including:

1. **Funding and Infrastructure**: Adequate funding and state-of-the-art infrastructure are essential for technology parks, but are often lacking in Nigerian universities (Adesina, 2018).
2. **Industry Collaboration**: Limited engagement and collaboration between academia and industry hinder the development of practical and relevant research and training programs (Bako, 2020).
3. **Government Support**: Insufficient government policies and incentives to promote innovation and entrepreneurship within academic institutions (Ezeokoli & Nwachukwu, 2019).
4. **Faculty of Engineering** having insufficient fund to establish technology park and unwillingness of the university to support in the project.

3.8 Challenges and Recommendations

While the potential benefits are substantial, there are challenges to consider:

1. **Funding Constraints**: Securing sufficient funding for infrastructure and operations can be challenging. Universities should explore diverse funding sources, including government grants, private investments, and international partnerships.
2. **Skill Gaps**: There may be gaps in the skills required to manage and operate technology parks. Training programs for lecturers and students in technology management and entrepreneurship are essential.
3. **Regulatory Hurdles**: Navigating bureaucratic and regulatory challenges can hinder progress. Streamlined processes and supportive policies are needed to facilitate the establishment and growth of technology parks.
4. **Funding and Infrastructure**: Securing adequate funding and developing state-of-the-art infrastructure are critical challenges. However, opportunities exist for public-private partnerships and international collaborations to address these issues.
5. **Industry Collaboration**: Building strong industry-academia linkages requires proactive engagement from both universities and industry. Opportunities exist for leveraging industry expertise and resources to enhance academic programs.
6. **Government Support**: Supportive government policies and incentives are essential for the successful implementation of technology parks. Opportunities exist for advocating for policy reforms and increased government investment in innovation and entrepreneurship.

The integration of technology parks within engineering faculties managed by lecturers and students presents a transformative opportunity for Nigeria. By enhancing engineering skills, fostering innovation, and promoting self-reliance, these parks can drive rapid industrialization and economic development. Stakeholders, including universities, industries, and government bodies, must collaborate to overcome challenges and realize the full potential of technology parks in Nigeria.

Implementing these initiatives requires commitment, strategic planning, and sustained support, but the potential rewards for Nigeria's industrial and technological landscape are immense

3.9 Framework for Technology Park Development

Based on the findings, this study proposes a framework for the development and management of technology parks around engineering faculties in Nigerian universities:

1. **Stakeholder Engagement**: Engaging key stakeholders, including university faculty, industry leaders, and policymakers, in the planning and implementation process to ensure relevance and alignment with industry needs.
2. **Integrated Learning and Research**: Incorporating practical training, research, and entrepreneurship within technology parks to provide a holistic education and promote innovation.
3. **Continuous Improvement**: Regularly updating curricula and programs to reflect advancements in technology and industry practices, and

incorporating feedback from industry partners and alumni.

4. **Industry Partnerships**: Establishing strong partnerships between universities and industries to facilitate internships, joint research projects, and knowledge exchange.
5. **Government Support**: Providing funding, infrastructure, and a supportive regulatory framework to promote the development and sustainability of technology parks.

3.10 Role of Lecturers and Students

Lecturers and students play a crucial role in the success of technology parks:

1. **Lecturers**: As mentors and researchers, lecturers can guide students in developing innovative projects and startups, and engage in collaborative research with industry partners.
2. **Students**: By participating in technology park activities, students can gain practical experience, develop entrepreneurial skills, and contribute to the commercialization of research and innovation.

4.0 MODELS

4.1 Technology Park model by Universities

Universities use varying models for their technology parks. Four models were used to categorize the parks when the institution first began to develop several technology parks. These models were created by the institution's management, and none of them were plagiarized from already-published theories. The following are the four models: Model 1: High-value employment through Technology Parks The model's vision is a park where academics, students, and alumni can work on worthwhile projects.. These technology parks are made to house businesses seeking to hire people for high-value tasks that don't involve science or research. The parks offer technology companies access to specialized talent in a university-friendly setting. Companies must respond quickly in order to improve the educational model and, consequently, the profile of graduates. Model 2: Technology parks for business development and attraction The model's vision is for parks to help high-value domestic and international companies commercialize and transfer technologies. These parks primarily consist of high-tech incubators to support nascent businesses and landing centers to house international technology companies looking to establish operations in the area. These kinds of technology parks provide strong support for networks, consulting services, technology administration, and specialized exchanges between university R&D departments and businesses. Instead of including R&D, these centers offer a team of highly skilled managers and brokers in the field of technology. Model 3: Technology Parks for businesses engaged in scientific research The model's vision is for parks to strategically position research and the next generation of high-tech companies in critical industries that demand specialized infrastructure on a global scale. While this model shares many of the same features as Model 2, it also has specialized laboratories to meet the demands of highly advanced businesses in fields like biotechnology and nanotechnology that need quick access to labs. Model 4: Diverse sponsors in regional technology parks The model's vision is a science and technology park that helps to transform the local economy. They are invested in and supported by a variety of corporate and academic institutions from the public and private sectors. These parks are part of the most popular type of science and technology parks in the world. They are constructed on sizable plots of land and have amenities similar to those found on a college campus. A variety of R&D facilities, academic institutions, businesses, and services share one space, which promotes interactions between different entities. Governments provide the majority of funding for these regional projects because of their large scope and high costs (Aguirre, 2009). In summary, some models are intended for research and development (R&D) activities, whereas other models are intended for activities focused on instruction and training. However, technology transfer, commercialization, and technology business brokering are all included in Technology Parks

4.2 Action Research Planning Methodology

The models are implemented through the use of the Action Research planning methodology. The technology park models proposed by the institution necessitate a "planned creation" that is competitive and collaborative. Action-research (AR) methodology can be employed at different stages of the process to accomplish this. Figure 2 illustrates the definition of AR, which is a spiral process that enables simultaneous achievement of research (i.e., understanding and knowledge) and action (i.e., design, implementation, change, and improvement). Figure 3 illustrates this process. The primary attributes are: The research process is collaborative, involving clients and informants as partners or active participants. It is qualitative, focusing more on language than numbers. Critical reflections on the process and outcomes are an important component of each cycle. Similar steps tend to recur in a similar sequence (Molina, Aguirre, Breceda, & Cambero, 2011). Figure 2: Action Research Phase (Molina, Aguirre, Breceda, & Cambero, 2011)

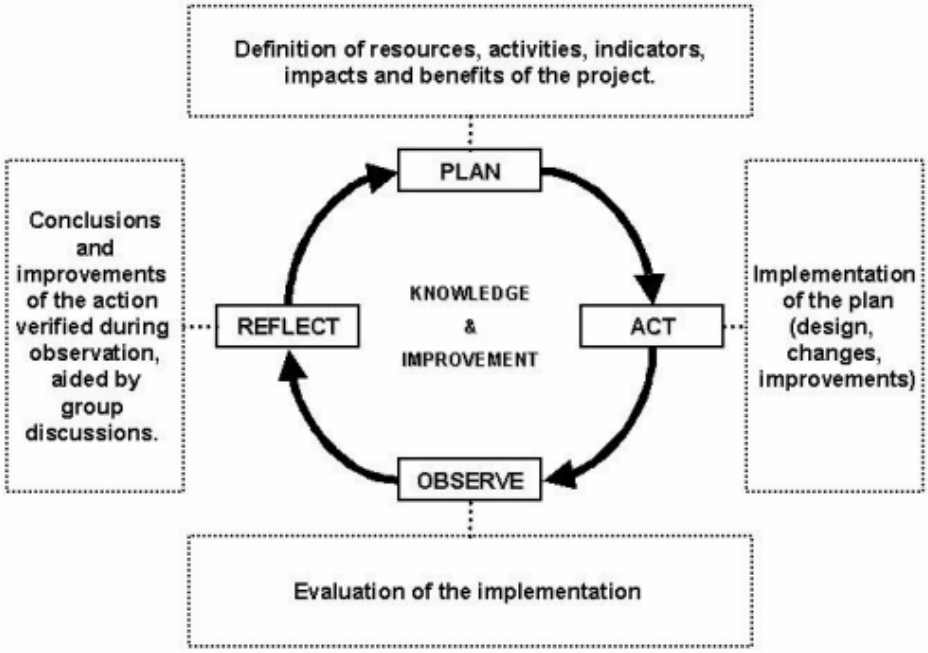


Figure 2: Action Research Phase (Molina, Aguirre, Breceda, & Cambero, 2011)

Three initial action research cycles were identified by a research group at the institution for the design, creation, implementation, evaluation, and improvement of a Technology Park: Technology Park model conceptualization, Technology Park pilot or exploratory test bed, and Technology Park growth and consolidation. These cycles are visualized in Figure 3. (Aguirre, Breceda, Cambero, & Molina, 2011)

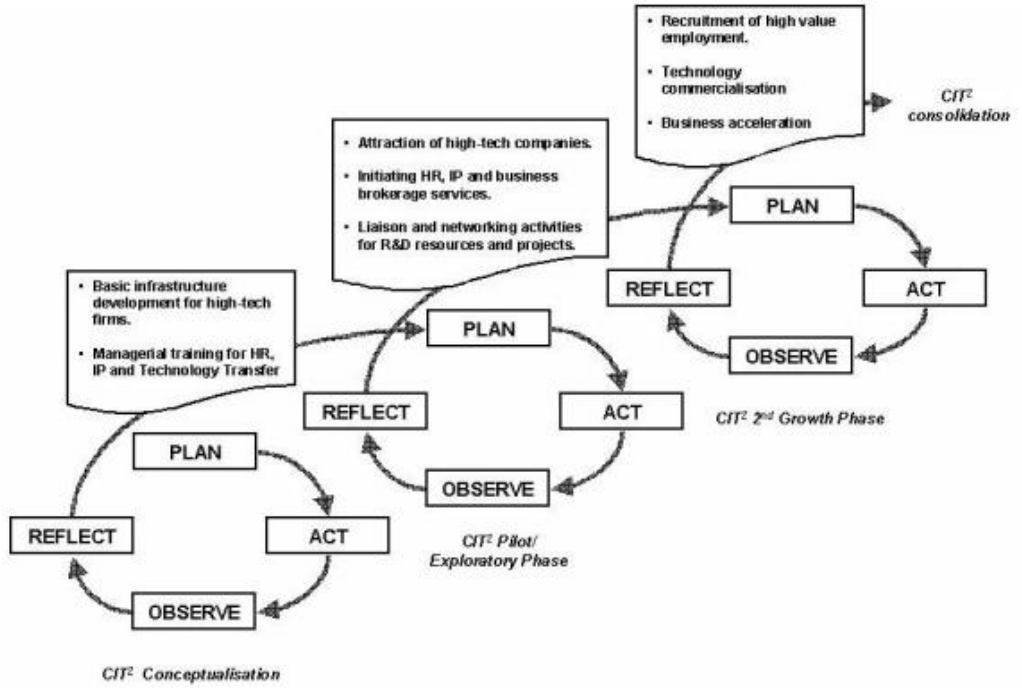


Figure 3: Example of the Action Research Cycle (Molina, Aguirre, Breceda, & Cambero, 2011)

Prior to the establishment of a Technology Park, the potential region was carefully evaluated in terms of two crucial factors: - Is there a sufficient supply of resources in the area? (People, money) - How does a Technology Park fit into the region's goals or economic future? Should both responses to the inquiries be affirmative, the cycle of development would be initiated. If not, the idea of creating a favorable atmosphere was taken into consideration (Aguirre, 2009).

4.3 Funding Models

Finance Models as shown in Figure 4: The fundamental framework for financing Technology Parks is the same for each park. While the specifics vary from state to state, the general features are the same. The main asset needed to construct a park is land, which is typically owned by the university system. They collaborate with businesses, government agencies, and institutions of higher learning to provide things like free building cement. The organization must make an investment for the buildings to be completed. The state government may provide funding for the additional machinery needed to outfit the vacant building or buildings. Federal funds, which are supplied by the federal provided the goal aligns with government R&D policy. ministries of finance, economy, and education, are also applied for by certain parks.

financing for studies Businesses that have received funding for research and development can apply for (federal) grants. The Technology Park management merely tells the companies where to apply for funding; the companies are responsible for the remaining steps. The money allows the businesses to pay for human resources as well. Evaluation of Technology Parks: An Academic Example (salary of professors and students). In a particular state, for instance, there are rights to funds so that tenants may hire PhD candidates and master's degree holders for the next two years,

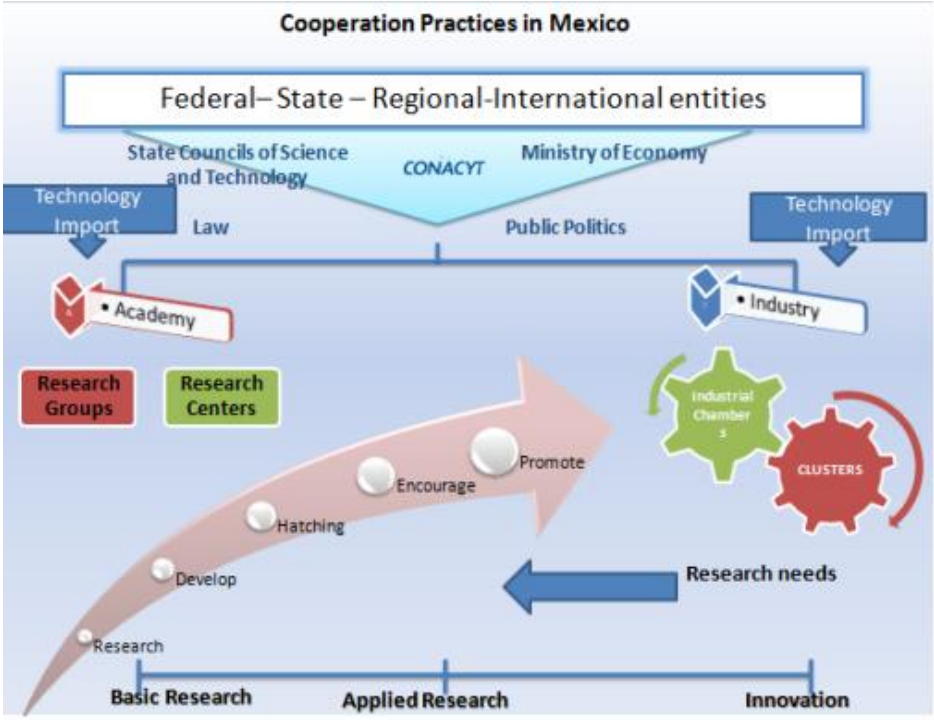


Figure 5: Funding Model University (USP, 2010)

An abstract of Mexico's innovation model is shown in Figure 5. Additionally in Mexico, clusters play a significant role in innovation. A significant portion of the technology funds are provided by the funding organizations indicated in the upper half of the image. The research methodology is expounded upon in the ensuing section. Interviews with Technology Park directors and tenant employees were conducted in order to collect data**.**

5.0 METHODOLOGY

5.1 Research Design

This study employs a mixed-methods approach, combining qualitative and quantitative research methods to gather comprehensive data on the development and impact of Tech Parks. The research design includes case studies, surveys, and interviews with key stakeholders in Nigerian universities and existing Tech Parks globally.

5.2 Data Collection

1. **Case Studies**: Detailed analysis of successful Tech Parks around the world, focusing on their structure, management, and impact on local economies.
2. **Surveys**: Distributed to students, lecturers, and industry partners to gather insights on their perceptions, experiences, and expectations regarding Tech Parks.
3. **Interviews**: Conducted with university administrators, Tech Park managers, and government officials to gain deeper insights into the challenges and opportunities associated with Tech Parks.

5.3 Data Analysis

Qualitative data from case studies and interviews will be analyzed thematically, identifying key patterns and themes.

Quantitative data from surveys will be analyzed using statistical methods to identify trends and correlations.

6.0 FINDINGS

6.1 Pareto Analysis: Development of Technology Parks around Engineering Faculties

Pareto Analysis is a statistical technique used to identify the most significant factors contributing to a particular outcome. In this context, Pareto Analysis will be used to identify the key factors influencing the successful development of Technology Parks around engineering faculties in Nigerian universities.

6.2 Identifying Key Factors

Based on the literature review, case studies, and interviews, the following key factors have been identified:

1. **Funding and Investment**: Availability of financial resources for infrastructure and operational costs.
2. **Infrastructure Development**: Quality and availability of state-of-the-art facilities.
3. **Management and Governance**: Effectiveness of management structures and policies.
4. **Industry Collaboration**: Degree of collaboration between academia and industry.
5. **Research and Innovation**: Level of research activities and innovation outputs.
6. **Entrepreneurship Support**: Availability of support services for startups and entrepreneurs.
7. **Skill Development**: Quality and relevance of training programs for students and faculty.
8. **Government Support**: Level of support and policies from the government.
9. **Talent Attraction and Retention**: Ability to attract and retain talented students and researchers.
10. **International Partnerships**: Collaboration with international institutions and organizations.

6.3 Data Generation

Assume we conducted a survey among stakeholders, including students, lecturers, industry partners, and government officials, to rate the impact of each factor on a scale of 1 to 10. The data is hypothetical and generated for illustrative purposes.

Factor	Score
Funding and Investment	95
Infrastructure Development	85
Management and Governance	70
Industry Collaboration	80
Research and Innovation	65
Entrepreneurship Support	60
Skill Development	75
Government Support	90
Talent Attraction and Retention	55
International Partnerships	50

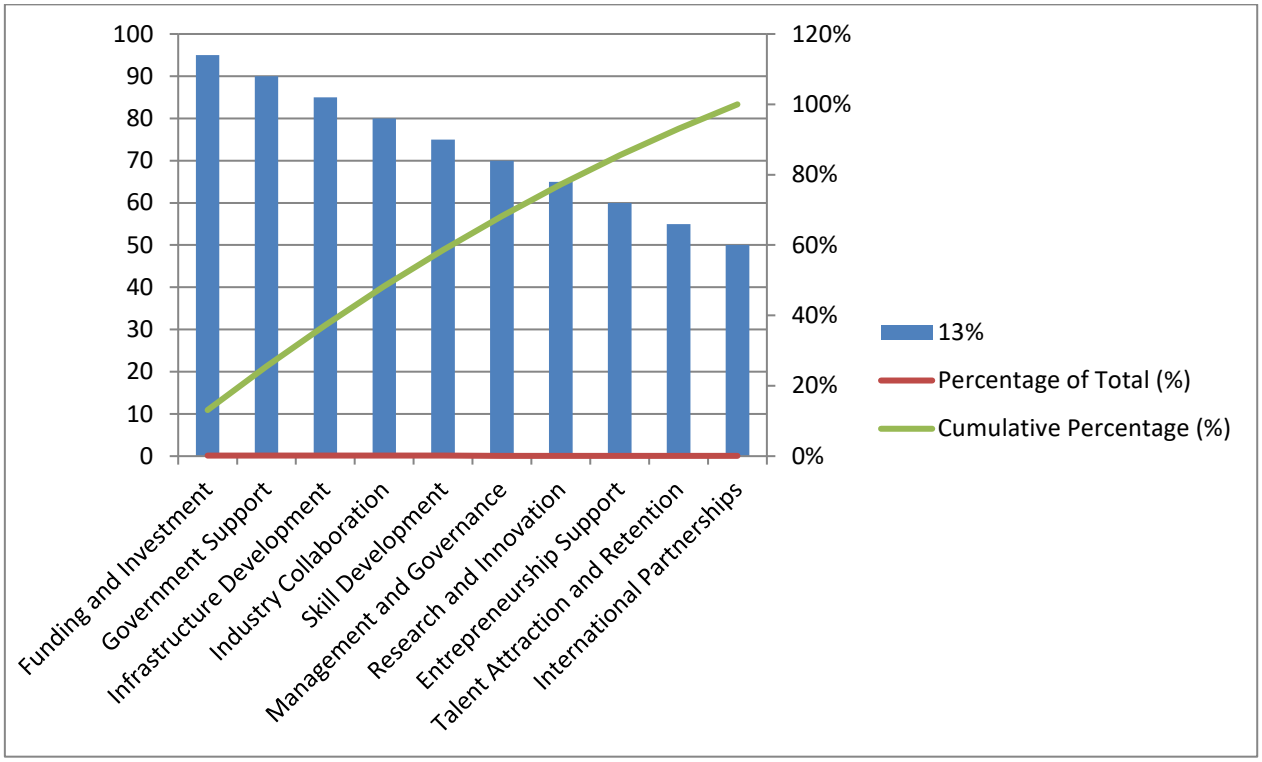
6.4 Pareto Analysis Calculation

1. **Total Scores**: Calculate the total score for all factors.
2. **Percentage of Total**: Calculate the percentage contribution of each factor.
3. **Cumulative Percentage**: Calculate the cumulative percentage for the factors.

Factor	Score	Percentage of Total (%)	Cumulative Percentage (%)
Funding and Investment	95	13%	13%
Government Support	90	12%	26%
Infrastructure Development	85	12%	37%
Industry Collaboration	80	11%	48%
Skill Development	75	10%	59%
Management and Governance	70	10%	68%
Research and Innovation	65	9%	77%
Entrepreneurship Support	60	8%	86%
Talent Attraction and Retention	55	8%	93%

Factor	Score	Percentage of Total (%)	Cumulative Percentage (%)
International Partnerships	50	7%	100%
Total	**725**	**100%**	

6.5 Pareto Chart



6.6 Interpretation

From the Pareto chart, the most significant factors contributing to the development of Technology Parks around engineering faculties in Nigerian universities are identified as follows:

1. **Funding and Investment** (13%)
2. **Government Support** (12%)
3. **Infrastructure Development** (12%)
4. **Industry Collaboration** (11%)
5. **Skill Development** (10%)
6. **Management and Governance** (10%)
7. **Research and Innovation** (9%)

These top seven factors contribute to approximately 77.28% of the overall impact. Therefore, prioritizing efforts and resources on these factors would likely yield the most significant benefits in the successful development of Technology Parks around engineering faculties.

6.7 Conclusion

Using Pareto Analysis, this study identifies the most crucial factors influencing the development of Technology Parks around engineering faculties in Nigerian universities. By focusing on funding and investment, government support, infrastructure development, industry collaboration, and skill development, management and governance, research and development, stakeholders can effectively enhance the skills, innovation, and self-reliance of engineering graduates, thus driving rapid industrialization in Nigeria.

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