© OCT 2026 | IRE Journals | Volume 10 Issue 4 | ISSN: 2456-8880
DOI: https://doi.org/10.64388/IREV10I4-1723646

Technology Transfer of Aero Derivative Gas Turbine - The articulated Journey to Nigeria Industrialization

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Abstract- ***A study premised on technology transfer from developed economy to Nigerian developing economy. LM2500 plus G5 aeroderivative gas turbine is the base technology. The technology transfer model applied in this transfer transaction is Bar-zakay Model (1970). This is a qualitative model made up of four stages of search, adoption, implementation and maintenance. It is classified into donor and recipient. There is a further overlapping interface classification of technological forecasting between stages one and two, long range planning between stages two and three and project related intelligence between stages three and four. The need for power generation and gas compression using LM2500 plus G5 aero derivative gas turbine was identified in line with the Nigerian Technology Acquisition and Promotion Act. Preliminary design and modeling have been done in previous research work. The identified engine has availability rating of about 98%. There shall be foreign exchange savings from stoping the equipment importation, improved economy, job creation, self-reliance and opportunity for further research and development. The desirability of aero derivative technology in the Nigeria industrial sector was also established. The equipment is already being utilized in power, oil and gas sectors for power generation, gas compression and ship propulsion in the marine industry. Investing in the local design and manufacturing of aero derivative gas turbine for local consumption and export would be a major game changer in the power, oil and gas industries. A capable organization shall be set up with all the bureaucratic support systems, interrelationship between the organizational people and systems shall be established and their roles and responsibilities clearly defined at the second phase of the technology transfer business (implementation stage)***

Key words - Technology, Transfer, Search, Adaptation, Implementation, Maintenance, generation, propulsion.

I. INTRODUCTION

This research created a blue print for technology transfer to the Nigerian economy. It is a journey towards the end and not the end in itself. Numerous literatures reviewed indicated that no nation is developed in isolation. A nation's developmental stride is a reflection of its technological acquisition, research and development ability. It is pertinent to minimize technology and information gap between technology donor and receiver. Therefore, perfection of the technology transfer transaction of the four major components of aero derivative gas turbine to the Nigeria industrial space is critical. Preliminary design, modeling, materials selection, manufacturing, installation, operation, maintenance, sustainability studies and implementation are the desired progress. The major components of interest are compressor, combustor, high-pressure and low-pressure turbine. This shall create employment opportunities for more Nigerians with visible improvement in power generation, oil and gas exploration at reduced cost and thereby creating foreign exchange savings from importation of this equipment into the country. This research will also increase literature in this critical cost consuming section of the industry

II. LITERATURE REVIEW

Hans & Lutje (2025) presented that technology transfer is the transfer of knowledge and technicalities. It is a collection of input and output process, exchange of services within and across the society, industries, and nations. The three types of technology transfer are inside – out (from an organization that has the technology to another organization that requires the technology), outside – in (received by the organization in need of the technology from the organization that has the technology and then out – in – out. This is the combination of first and second types, a process where the two organizations have technological knowledge to transfer and to receive.

Further classification indicated a categorization of technology transfer into ten types. These include: a business with or without profit motive, commercial

with profit motive, inner spill over model (to satisfy the need of functional system), science communication, research process preparation, research funding, exchange of personnel and technology, contract research, the incubator model, and finally the innovation ecosystem model.

Coral (2022) viewed technology transfer as an act that encourages investors, firms and industries to participate in technological development by sharing, accepting new technology, skill and embarking on research and development. Technology transfer has the collaborative tendency in technological advancement and social economic development. Technology transfer could be vertical (across different stages of product development), horizontal (technology sharing between different entities and manufacturers), internal (within the organization), external (between University technology transfer Office and firms), commercial (for the purpose of revenue generation), non-commercial (for societal benefit and others (international technology transfer, Government to industry technology transfer, industry to industry, reverse, forward and interactive technology transfer)

Wenwen et al (2025) presented that there is an affirmative relationship among technology transfer, urban innovation and development. This proposition was supported by theoretical framework and empirical analysis using benchmark regression. The analysis however, indicated a positive effect of both international and local technology transfer on urban industrialization development and development in China. The analysis indicated that international technology transfer has more positive impact on urban development than local technology transfer. One of the key elements that aided technology transfer both internationally and locally was industrial and organizational collaboration.

Belinsky (2025) opined that technology transfer is an important element to economic growth, technological advancement and industrialization. Stabilizing innovation, innovation improvement, securing competitive advantage and wining end user trust is directly link to research, development and technology transfer. Technology transfer is the flow of knowledge, technical information and proprietary information from the donor country to another or from one organization to another. Resource training and infrastructural development support to the technology transfer receiver is critical to a successful transfer transaction.

Technology can be transferred freely by the donor organization or purchased by the receiving organization. During technology transfer transaction, ideas, discoveries and processes are shared through licenses and joint venture agreement. It is pertinent to note that technology transfer require legal framework and standard to eliminate, reduce and manage conflict that may arise. The World Trade Organization (WTO) is one of the standard organizations that support in technology transfer transactions. The United Nations (UN) and World Intellectual property Organization (WIPO) also support in technology transfer agreement between and among organizations or intercontinental transfer to ensure the various transactions are perfected with minimum set standard. The European Union member states operate a single digital market place for technology transfer. This has significantly ensured advancement in technology among the EU countries.

The effect of global digitalization in technology transfer is enormous in exchanging technologies across international borders. This is made possible by globalization, internet of things and artificial intelligence. One of the major tools for technology transfer is digital platform. It is used widely for both local and international technology transaction. It supports better and faster movement or sharing of information between and organizations or countries. Communication is done in the course of the transaction via digital platform. Though digital platform has a lot of wonderful advantages, there are also numerous set back if not properly secured and managed. Cyber security, cost and maintenance are critical elements to be considered.

Another challenge in technology transfer transaction is the technology gap between donor organization and the receiving organization. A lower gap is preferable and much easier to close with lower resources and shorter time. Though higher gap is surmountable, it

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DOI: https://doi.org/10.64388/IREV10I4-1723646

requires more effort, proper planning and execution to manage the transaction to fruition. Technology transfer among the EU member states from 2014 to 2023 is quiet massive as indicated below in figure 2.95.

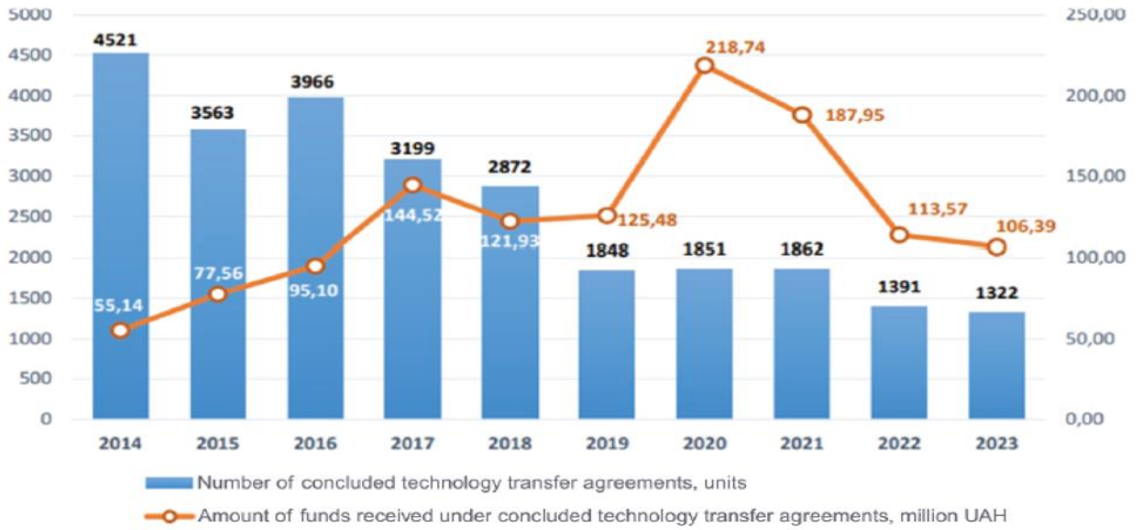

Figure 2.9.5: Number of Technology Transfer agreement and the amount of fund received in 2014-2023 in the EU (Belinsky, 2025)

Haofeng & Jingxian (2024) posited that in technology transfer, there are several important and critical responsibilities to be performed by technology transfer intermediaries (individuals, group of persons who serve as middle men in technology information sharing). These responsibilities include but not limited to building of trust, sharing of information, ensuring transaction efficiency between and among the concerned parties, fast track and manage technology information sharing by leveraging on their professionalism in technology information management and dissemination. It is the responsibility of technology transfer intermediaries to initiate and propagate trust in the transaction of confidential knowledge sharing.

The scientific and technological qualities of technology transfer information possessed by the supplier and the receiver are very important for a successful technology transfer transaction. The smaller the gap between parties, the better and easier to achieve a successful technology transfer transaction. It then means, studies, experience and training are also critical elements in this business. The relationship between parties must be good enough and properly managed to ensure consistency in information sharing and support from the provider to receiver. This brings to light, the importance of interrelationship between the stakeholders.

The technology transfer intermediaries link technology demanders with service providers. It is pertinent for these intermediaries to ensure the value and property right of the technology is not altered during this transfer process. Examples of technology transfer intermediaries are university technology transfer department, technology transfer centers and technology transfer consulting firms. Technology transfer transcends beyond sharing technical information, this includes sharing of strategic processes and procedures, labor skill sharing, tools and then scientific knowledge sharing referencing the aims and objectives of the transaction. This transaction must operate under the premise of acceptable regulatory policies. It should be noted that technology transfer is not devoid of uncertainties and unpredictability. But the ability to manage and resolve eventualities determine to a large extent, the success of the technology transfer project.

Linda (2024) presented that knowledge transfer is learning from each other. It is a process where an

organization or department affects the activities of others by information sharing and supporting to effect a change in the organization classified as the receiver. The donor share information with the receiver for the purpose of technological advancement or improvement in processes and procedures. We learn every day from the experience of others for the purpose of improvement.

It is believed that there must be a reasonable level of knowledge persistency in the donor organization for knowledge to be transferred and received by the receiving organization. Knowledge is embedded in organizational members, tools and tasks. When organizational members are repository of a particular technology, the employees have the skill that is acquired, tested, certified and good enough to share for the purpose of technological and process advancement. Software used as tools of trade can also be repository of knowledge with programmed instructions for the purpose of executing certain activities. Tasks are considered to be element of knowledge repository when technology is embedded in the procedures and processes of operation and in activities execution. Knowledge can also be embedded by cross linking the three fundamental elements of members, tools and tasks. Knowledge transfer mechanism is dependent on the type of knowledge to be transferred.

We have the tacit knowledge, where the knowledge is tactical and difficult for member to articulate. In this case, on the job training and observation is required to transfer knowledge from the donor to the receiver member. Some actions by the donor may not be easily articulated during activity performance.

A second type is the casually ambiguous knowledge, though related to tacit knowledge, but is different. This is an organizational way, practice, procedure of doing things better without understanding the reason why present output is better than previous output. Knowledge will therefore be difficult to transfer since the factors contributing to this success are not known. Since the donor organization does not understand what to transfer, the idea of copying exact approach does not work here.

The third type of knowledge is the demonstrable type. This is the type of knowledge that can be transferred from the donor organization to the receiving organization. This can be demonstrated by the donor member to the receiving member. The donor member is able to convince the audience about the new technology efficacy with overwhelming evidence as appropriate.

The fourth type of knowledge is the complex knowledge; this is another very important type of knowledge, where the knowledge to be transferred is a complex type with many interdependent components to be studied and understood before the technology transfer can be termed successful. In this case, training and retraining is required.

Other types of knowledge are declarative, procedure and interpretable knowledge (level of understanding of cause-and-effect relationship).

Assefa (2024) presented that technology is the application of science, economics and technical knowledge in solving societal problems and advancing living standard. It involves invention and innovation. Channeling scientific and technical research result to the industry and society is technology transfer. Knowledge transfer involves movement or sharing of skill, resources, tools, design and specification data, innovation, invention, software and any other proprietary information from a department in an organization to another department or from one organization to another. Technology transfer can be from one country to another. This transfer must be done within the ambit of regulatory standard and policies governing the transaction. International technology transfer is a transfer across the borders and can be done through licensing agreement, franchising or joint venture. The relationship between the industry and university or between the donor and receiver is important to fulfill the agenda of technology transfer. The university organization and manufacturers collaborative effort promote technology transfer, thereby aiding technological development. To support the effort of interrelationship between university organization and the manufacturers, the universities created technological transfer intermediaries such as technology transfer department and research centers.

Technology transfer transaction involves exchange of knowledge, skill, resources and capabilities. A triple helix relationship of university – industry – government model was used in this study. Clearly indicating the roles and responsibilities of stakeholders involved in technology transfer.

Technology transfer transaction helps improve the competitive advantage of receiving company, reduce cost of research and developing the product from concept, encourages intercompany relationship, improve standard of living and the economy of receiving nation and enhance productivity. There are also important barriers that need to be managed by appointed technology intermediaries. These barriers include but not limited to culture, communication, interest, values, objectives, infrastructure and attitude differences between the donor organization and receiving organization.

Jerry & Jacob (2024) presented that developing countries or growing economy aspiring for higher ground in technology, seek technology transfer from developed or industrialized nations to improve their technological standard and better their economy. A typical study in this case was between Soviet Union and the United States of America. It was emphatically clear that technology transfer benefits the receiving organization. China manufacturing organizations, supported by the Chinese government and a host of other countries benefited from technology transfer by joint venture agreement. China, Soviet Union, Italy and other countries were determined to progress their technological advancement. Therefore, technology transfer was positioned on the critical path to achieving the desired goal. Technology was transferred from the donor organization to receiving organization for economic gains on the part of the donor nations and both economic and industrialization gains on the part of the receiving nations.

Historically, in the early 1920s, the Soviet Union decided to source for foreign equipment and expertise for the nation economic stabilization and industrialization. Firms were encouraged to invest in Soviet Union and then moved forward to perfecting the technology transfer transaction and acquiring the required foreign technology from United States of America. This was done under the premise of technology transfer agreement. Other countries like Germany and Japan signed their technology transfer agreement in an attempt to adopt the United State technologies.

Though this paper was primarily done to establish the reason why organizations shared their proprietary information with the Soviet Union, it did not fail to emphasis the economic and technological benefit of technology transfer to the receiving organizations or countries.

Vivien et al (2024) presented that some or all the traditional universities has advance from the original roles and responsibilities to entrepreneurial university model. The universities have now in addition to teaching, learning and research ventured into innovation, implementation and development of entrepreneurial activities aimed at technological advancement, income stabilization, national economic improvement and industrialization. This fit was achieved by legalizing a policy framework for science, technology and innovation laws. These policies major objectives were to empower the universities to manage their innovation, protect their intellectual properties and technology transfer transaction.

Furthermore, it was a challenging transition period from the traditional university responsibilities to the entrepreneurial responsibilities. There was a convincing need to strengthen the existing department or functional units of the university system and create more on need basis. Some of these functional units are research, innovation, technology transfer offices, administration and legal to ensure the target of entrepreneurial status is not only achieved, but sustained. This process started by information sharing and educating the university community of professors, lecturers, none academic staff and students of the new dawn or direction of the university entrepreneurial involvement. Sensitization workshops and meetings were organized across the universities communities to ensure to ensure a collaborative and team spirit to sail in the new direction. The result was overwhelming and encouraging. The change was difficult at the beginning; it gradually won the hearts and mind of parties involved in the new era with remarkable

stability and progress. The dynamic culture of the university community in appreciating and accepting the entrepreneurial intent of project leadership will not only develop the university community, but the entire society and nation at large.

The cultural transition leadership did excellently well in initiating, communicating, sensitizing and implementing the noble research, innovation and advancement of technology in both the university community and the outside world at large. Their effort to a large extent changed the old narrative which classified the university community as a cost consuming entity to an entrepreneurial organization aiding societal technological advancement and industrialization.

Samuel & Nguyen (2023) posited that technology transfer and organizational collaboration should be effectively managed to achieve the desired goals of technology transfer. Technology transfer has an immense commercialization potential for the inventor on one end, the receiver and the general public at the other end. Technology transfer, research and development are great opportunities to sustain the current technologies and further development for the benefit of mankind.

Technology transfer intensity is the level and extent to which knowledge is shared between and among organizations and countries involved. This sharing could be from academic institution, government agency to manufacturing industries or from one manufacturing industry to another. Technology transfer could also be from one country to another. This can be done formally through licensing agreement, joint venture agreement, consulting services, and research and development collaboration. Technology can also be transferred informally by sharing information between and among individuals, communities and organizations through inter personal relationship and collaboration. It is important to note that digitalization of business process (the transformation of physical asset, processes, and format into digital format) is one of the major catalysts of technology transfer. It is easier to share knowledge and information within a digitalized environment business.

Matthias, M (2023) presented that some of the major challenges put forward for the entrepreneurial universities are technological innovation, transfer and sharing of knowledge to address both social and technological challenges in the society. This will support, ensure and guarantee technological sustainability and development with an added benefit of commercialization gains. The importance of technology transfer cannot be over emphasized, considering its benefit to country industrialization, social, economic growth and sustainability.

Government of developed nations has research and development components in their governance system in alignment with entrepreneurial universities, the military and private sectors for the purpose of sustaining and advancing technologies and finding better ways of approaching issues of both social and economic concern.

It is important to note that the entrepreneurial universities have now improved from the traditional primary focus of teaching and research to entrepreneurial activities and responsibilities as an additional value to make a better society.

Samuel (2023) presented that there is an established relationship between technology transfer, research and development. To ensure technological system sustainability, technology transfer is critical. Though the study majored on green technology transfer, its technology transfer and knowledge sharing framework is applicable across the board of new technology acquisition by interested parties. To this end, there must be concerted effort for firms or stakeholders to buy into the transaction of technology transfer and at the same time adhering to the transaction environmental ethics. Manufacturing is a complex sector of the world economy entangled with stakeholder's quest to gain competitive advantage over others. Advancing technology means research, development and technology transfer. This is one of the assurances of the ability or readiness to gain competitive advantage over others. For a technology transfer project, research and development to be successful, the question of stakeholder's capabilities must be answered. These capabilities include, but not limited to funding availability, expertise in the area of

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DOI: https://doi.org/10.64388/IREV10I4-1723646

interest, plan for sustainable innovation and an organized technology network. The ability of stakeholders to comply with transaction regulatory standard is also an important element of knowledge or technology transfer.

Technology transfer is a means to sustainable technology and innovation. It is buying and acquiring knowledge by the receiver for technological and economic gains. Funding as stated earlier is one of the key capabilities to be possessed by the receiver. Government funding is one the major source of income for technology transfer, research and development. The use of government funding, subsidy and tax relief were emphasized for the purpose of sustainability and development.

Research and development encourage the sharing of technological information and expertise between and among firms inside and outside the organization, while operating within the confine of regulatory standard and policies. It is important to note that the quest for technological advancement result to research and development. Research and development result to sustainable development through technology transfer.

III. TECHNOLOGY TRANSFER

3.1. Bar-zakay Model

The Bar-zakay technology transfer model was utilized in this research. It is a qualitative foundational model in the technology transfer business. It recognizes the fact that, transfer is between donor and recipient. The model is a four stage process of technology search (identification of opportunity, needs, establishment of policies, contact channels and building capacity of trust, performance and dedication), technology adaptation (evaluating implication, desirability, alternatives and effectiveness), technology implementation (by establishing a capable organization, considering peoples emotion, providing supporting element and ensuring bureaucratic support) and technology maintenance (by ensuring system compatibility with supporting elements, evaluating net benefits, evaluating side effects and performing continuous research and development). See figure 3.1

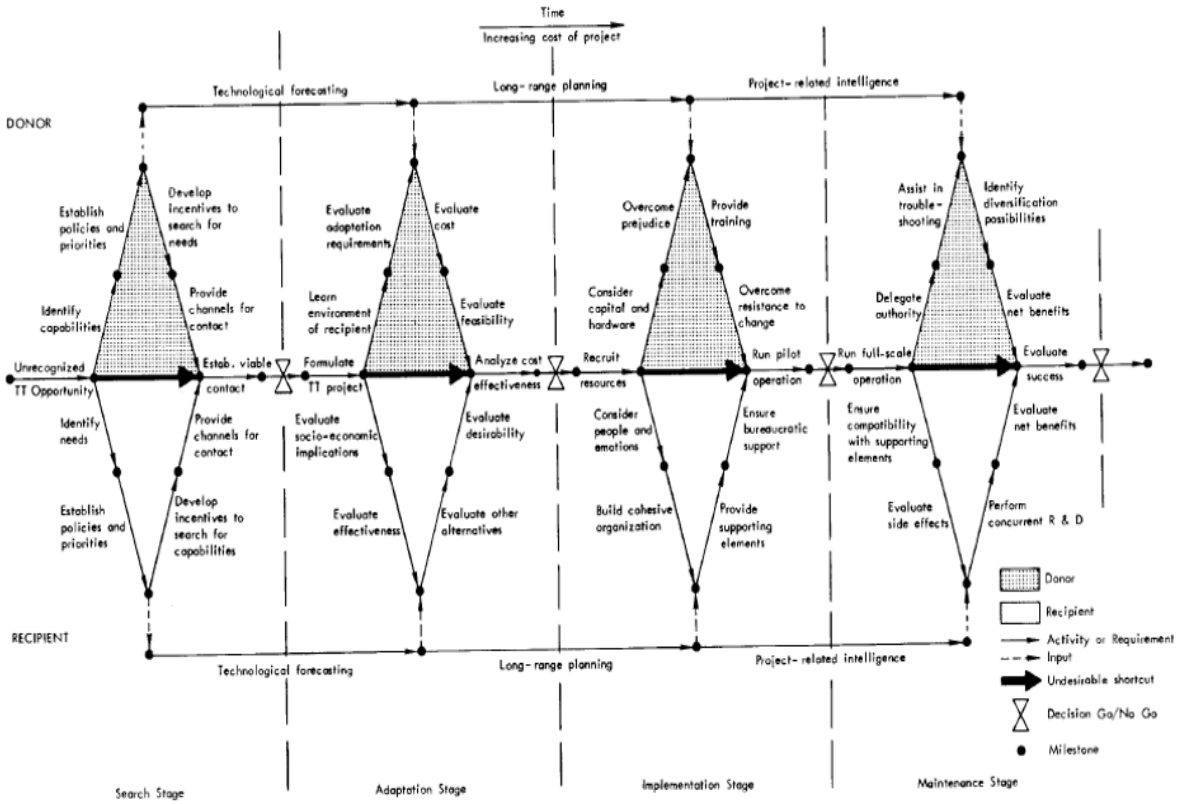

Figure 3.1: The Bar-zakay Technology Transfer Model

3.1.1. Technology Donor (American Investor)
The identified technology donor in this research is an American manufacturer. The manufacturer has experience in the design and manufacturing aero derivative gas turbine equipment, heavy duty gas turbine, medical equipment, electrical and a lot of other industrial equipment.

3.1.2. Technology Recipient (Federal Government of Nigeria and Nigerian Investors)
The technology recipient in this case shall be the Federal Government of Nigeria in partnership with interested investors. The Nigerian Government already has a constitutional frame work for technology reception and utilization.

3.1.3. Technology Search Stage
The referenced technology identified and modeled with improvement is LM2500 plus G5 aero derivative gas turbine. Preliminary design was done with improvement to generate 48 MW of electricity as against 30 MW of electricity. Identified improvements are introduction of intercooler to step down atmospheric inlet air temperature from about 30 degrees centigrade to about 15 degrees centigrade, ISO standard. Secondly, compressor stages were increased from 17 to 18 to improve compression ratio from 25:1 to 30.1, thereby increasing the power output of the turbine and generator for improved electric power output (Shaibu, 2026).

A country's industrialization is belted on science research, technology research, technology transfer and development. The aero derivative gas turbine is a great investment opportunity that has been identified. This opportunity shall be harnessed to support the Nigerian industrialization project for the purpose of both economic and industrial growth.

Furthermore, it was established that there is the need for improved power supply, industrialization, economic growth and foreign exchange savings. Considering the ever-expanding nature of Nigerian economy and the world at large, it is pertinent that Nigeria as a nation joins the league of industrialized nation for the purpose of in country utilization and exportation of manufactured product.

For the purpose of this research, I adapted the Nigerian policy on technology transfer (National Office for Technology Acquisition and Promotion Act). This policy is under the umbrella of National Office for Technology Acquisition and Promotion Act. It is a constitutional frame work for both the donor and receiver in technology transfer business. It factored in constitutional backing for the donor and receiver's intentions, expectations, guidelines and road map from technology search, identification, adaptation and implementation. It also considered maintenance, research and development for the purpose of the technology sustenance and growth. Communication shall be among agents of the Federal Government of Nigeria, directors of the interested investors in Nigeria and agents of the donor manufacturers in accordance with the constitution of both nations.

The resource team shall be carefully selected from experienced Nigerian nationals and foreigners on aero derivative gas turbine design, manufacturing, installation, operation and maintenance. This group of personnel shall be remunerated according to international best practice. The project shall be founded on integrity, transparency and trust. Milestones shall be clearly defined. Achievements shall be celebrated and compensated to encourage future best in class service delivery.

3.1.4. Technology Adaptation Stage
It is established that the aero derivative gas turbine is used for power generation, gas compression and ship propulsion. It has availability rating of about 98% (badeer, 2020). Investing in this noble project implies that there shall be foreign exchange savings from the equipment importation, improved economy, job creation, self-reliance and opportunity for further research and development.

The desirability of aero derivative technology in the Nigeria industrial sector cannot be over emphasized. The equipment is already being utilized in power, oil and gas sectors for power generation, gas compression and ship propulsion in the marine industry. New ADGT are being installed, changeout/replacement is done every six years of full utilization. Therefore, investing in the local design and manufacturing of aero derivative gas turbine for local consumption and

export would be a major game changer in the power, oil and gas industries.

The technology transfer project effectiveness is based on its estimated success level and therefore thorough fulfillment of the basic requirements of technology transfer. The aero derivative gas turbines imported from United States of America, Germany and Italy are already being used in the Nigerian industrial sectors. The technology donor is capable and has already localized the installation, maintenance and operation of this equipment in Nigeria. Outstanding elements are the design, manufacturing of the ADGT in Nigeria and creating Nigerian ownership. In an attempt to reduce the technology knowledge gap between the donor and recipient, preliminary design and modeling have been completed

3.1.5. Technology Implementation Stage

At the implementation stage, though planned for second phase of the transfer project, a capable organization shall be setup. I will create supporting element, while, considering peoples emotion and putting in place the system bureaucratic support (Human resources, quality control and quality assurance, purchasing, project management, environment health and safety, logistics, legal, finance, security, business development, sales, public relations and training). For the purpose of this research, the organization shall be represented by an organizational chart in phase two of the technology transfer business.

3.1.6. Technology Maintenance Stage

At this stage of the aero derivative gas turbine technology transfer maintenance, the system - made up of the organizational people, process, information and technology shall be collaboratively intertwined and interwoven with supporting elements of structure. These include human resources functions, roles, responsibilities, manager to subordinate ration, decision making plan, workflows, resource allocation, line of communications, deployed technology and tools, training plan, mentorship, culture, policies and feedback mechanism

Just like every business investment, it is time to evaluate the net benefit of the technology received. This evaluation shall be done by determining the benefit of the technology breakthrough in industrialization effort, foreign exchange savings, local utilization and export economic gains, localization and creation of employment opportunity and finally quality and safety standard achieved.

The side effect of the new technology on employees, facilities and the environment shall be evaluated. The outcome of these evaluations shall be incorporated into research and development planning. A structured research and development plan shall be deliberately incorporated into the overall structure of the technology transfer program. The research and development team shall be composed of seasoned and experienced scientist, technologists and Engineers and support teams.

IV. CONCLUSION

The effect on collaborative ability of the donor organizations, countries with the receiving organizations and countries cannot be overemphasized. There is also the need for effective allocation and utilization of technology transfer resources to achieving the set target of the technology transfer transaction. Technology transfer is a continuous adventure and lucrative investment that every promising and optimistic organization, country must be involved in. technology transfer is now the quickest and most reliable route to nations industrialization and development. China keyed into technology transfer transactions and has achieved so much in industrialization, competitive advantage and economic growth.

Conclusively, it is therefore recommended that both international and local technology transfer be encouraged, effective industrial or organizational collaboration, improvement on innovation, research, development, creation of technology transfer and acquisition hub and promote digital technological advancement to quicken the transaction of technology transfer.

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