SCIENCE, TECHNOLOGY & PUBLIC POLICY: IMPERATIVES FOR DEVELOPING ECONOMIES

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DEDICATION

To our families, scholars and professionals that will find this book useful in research and policy advocacy.

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We are grateful to God for His abounding Grace & Mercies towards us. To all, whose contact to our lives; both in literature & physically, has shaped our thoughts and left tremendous impacts, thank you.

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INTRODUCTION

INTRODUCTION

SCIENCE, TECHNOLOGY & PUBLIC POLICY: IMPERATIVES FOR DEVELOPING ECONOMIES

Science and technology are advancing at a dizzying pace and we are at a place today we could scarcely imagine fifty years ago. Concepts like space tourism or even cybersecurity and the policies governing these concepts seemed too farfetched and irrelevant. Today, they are part of our reality. Our societies evolve almost in tandem with technological innovations, each breakthrough influencing and being influenced by public policy. This dynamic interplay shapes not only the development of new technologies but also the socio-economic landscapes they inhabit. In "SCIENCE, TECHNOLOGY & PUBLIC POLICY: IMPERATIVES FOR DEVELOPING ECONOMIES," we explore this relationship, providing insights into how developing economies can navigate and leverage these advancements for sustainable growth.

The content of this book is enveloped into seventeen (17) chapters. Chapter one sets the stage with foundational definitions and characteristics of science and technology, and the evolution of technology. Chapter two then examines the meaning and nature of public policy, exploring its various conceptual categories and processes, culminating with an exploration of the critical nexus between science, technology, and public policy. In Chapter three the profound impact of technological revolutions on global modernization is discussed, and their significant effects on the global economy, including the pivotal role of networking in economic transformation.

Chapter four provides a historical perspective on primitive technology and its evolution. It explores the impact of scientific and technological advancements on the primitive age, paving the way for the development of intermediate technology. This is followed by Chapter five which traces the industrial revolution and its technological changes, with a particular focus on the history of technology development in Nigeria. This chapter offers a localized context that is crucial for understanding the broader themes of the book.

In Chapter six, we see an examination of the relationship between production functions, technical progress, and economic growth. Chapter seven goes further into various economic theories, including exogenous and endogenous growth theories, and the theory of creative destruction. These theories provide a framework for understanding the economic implications of technological change. Chapter eight addresses the ethical considerations in scientific research and technological innovation. It discusses the moral and political issues, the importance of socially responsible research, and the ethical and social implications of research breakthroughs. Leading into exploring both the positive and negative impacts of technology on society and the economy in Chapter nine.

Chapter ten investigates the dynamics of industrial competition, competitive parity, and the pursuit of competitive advantages. It examines the relationship between competitive policy and economic growth. Chapter eleven discusses technology transfer, and the diffusion and adoption of technology. Chapter twelve addresses the challenges and strategies for technology acquisition. It covers the choice of technology, creation of local capabilities, and barriers to technology acquisition, offering strategies to overcome these challenges.

In chapter thirteen, we see an application of the themes of this book in the military-industrial complex (MIC), and the consequences of technological advancements and research on MIC. Chapter fourteen goes further to provide a focused look at developing economies with a particular emphasis on the Nigerian situation. In Chapter fifteen and sixteen we explore further on the emerging and salient issues in science, technology and public policy today. Chapter fifteen centers on cybersecurity, data protection, and privacy concerns. While Chapter sixteen, treats the complexities of intellectual property rights, patents, and technological innovations is discussed.

Finally, the concluding chapter, chapter seventeen looks ahead to emerging trends in science and technology policy. It discusses the challenges and opportunities in regulating emerging technologies, providing a forward-looking perspective.

Otu Duke & Bassey Anam

PERSPECTIVES, RESEARCH AND POLICY FOCUS.

INVESTMENT IN SCIENCE AND TECHNOLOGY IS KEY TO AN AFRICAN ECONOMIC BOOM

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The African continent represents 20 percent of the earth's surface and is home to 1.3 billion people—likely reaching 2.53 billion people by 2050. It boasts 60 percent of the world's arable lands, large swathes of forests, 30 percent of the world's reserve of minerals, and the youngest population of any continent. Yet, despite these riches, it produces only 3 percent of global GDP, accounts for less than 3 percent of international trade (mainly primary commodities and natural resources), and shoulders 25 percent of the global disease burden. The picture is particularly bleak when it comes to research and innovation: Africa contributes just 2 percent of world research output, accounts for only 1.3 percent of research spending, and produces 0.1 percent of all patents.

How can a continent that has fueled the world's industrial revolutions, that helped drive the dominance of the mobile phone industry, and whose large store of rare earth minerals is integral to the global green energy transition tolerate such dismal statistics? A lack of investment in science and technology has undermined Africa's economic transformation at both the structural level (the shift of workers and resources from low- to higher-productivity sectors) and the sectoral level (the growth of productivity within sectors). This lack of investment has had far-reaching consequences: Without the economic and scientific infrastructure necessary for innovation, the continent has continued to rely on the colonial development model of resource extraction, which is both unsustainable and largely responsible for its debilitating poverty and aid dependency. These challenges have been compounded by economic fragmentation, as smaller markets constrain the long-term investments and patient capital that would foster innovation and drive technology transfer in the context of globalization.

The silver lining is that there is potential here with a growing recognition by policymakers of the role that science and technology can play in achieving national development goals and transforming Africa's economic growth story. Moreover, given the positive correlation between growth and environment that beget competition and innovation, competitiveness must be fostered. Thus, African countries must create an enabling environment through pro-innovation, pro-science, and pro-technology policies dedicated to overcoming barriers related to regulation, corruption, and investment, while enabling private-sector innovation, adaptation, and adoption. At the same time, African governments must also invest in creating an ecosystem that facilitates investment in science and technology in a way that will not just accelerate discovery but allow innovations to enter the marketplace more quickly. The tide of Africa's brain drain must be reversed by creating a world-class education and research infrastructure that will keep the best minds on the continent and attract new ones.

Bridging the skills deficiency gap in science, technology, and innovation is vital to unlocking Africa's potential and accelerating economic growth and prosperity. The best-trained, most talented researchers gravitate to environments where their work is leveraged by modern equipment, reliable utilities, and sufficient funding for supplies—and, perhaps most critically, where they can benefit from the presence of other talented people. Thus, the tide of Africa's brain drain must be reversed by creating a world-class education and research infrastructure that will keep the best minds on the continent and attract new ones. Already, South Africa leads the way here, with a robust research system comprised of excellent universities and science facilities that allow it to be a full-fledged contributor to the global scientific community and an integral participant in international collaborations.

As human talent is developed across the continent, investment in research, science, and innovation will increase dramatically across various sectors, including manufacturing, which will be a significant factor in helping Africa realize its development potential and narrow its income and welfare gaps. Business-to-business spending in manufacturing in Africa is projected to reach $1 trillion by 2050 - a trend that creates a massive opportunity for the continent's overall growth.

Creating an ecosystem where scientific culture can be central to economic transformation and policymaking decisions is a long-term investment that must not be at the mercy of either political or business cycles. Success will require effective tripartite (public-private-academia) collaborations and partnerships that will need to be sustained over time. If Africa can do this in the era of the African Continental Free Trade Area, the benefits of science, technology, and innovation can be marshaled for greater economic, social, and environmental sustainability, both on the continent and beyond.

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CHAPTER ONE:

THE CONCEPT OF SCIENCE AND TECHNOLOGY

The word Science comes from a Latin word "scientia" meaning "knowledge" and in the broadest sense, it is any systematic knowledge-base or prescriptive practice capable of resulting in prediction. Science can also be understood as a highly skilled technique or practice (Fara, 2009). In more contemporary terms, science is a system of acquiring knowledge based on the scientific process or method in order to organize a body of knowledge gained through research. Science involves the observation, identification, description, experimental investigation, and theoretical explanation of natural phenomena. The Webster's New Collegiate Dictionary gives the definition of science as "knowledge attained through study or practice" or "knowledge covering general truths of the operation of general laws, esp. as obtained and tested through scientific method and concerned with the physical world."

Science can also be seen as a branch of knowledge or study dealing with a body of facts or truths systematically arranged and showing the operation of general laws: for example, mathematical science Systemic knowledge of the physical or material world gained through observations and experimentation Systematized knowledge in general. Science is a continuing effort to discover and increase knowledge through research. Scientists make observations, record measurable data related to their observations, and analyze the information at hand to construct theoretical explanations of the phenomenon involved. Science is the pursuit of knowledge and understanding of the natural and social world following a systematic methodology based on evidence.

According to the Oxford American Dictionary, “Science is the intellectual and practical activity encompassing the systematic study of the structure and behavior of the physical and natural world through observation and experiment.”

CHARACTERISTICS OF SCIENCE

Fara (2009) has identified the following characteristics of science:

Objectivity

Scientific knowledge is objective. Objectivity simple means the ability to see and accept facts as they are, not as one might wish them to be. To be objective, one has to guard against his own biases, beliefs, wishes, values and preferences. Objectivity demands that one must set aside all sorts of the subjective considerations and prejudices.

Verifiability

Science rests upon sense data, i.e., data gathered through our senses—eye, ear, nose, tongue and touch. Scientific knowledge is based on verifiable evidence (concrete factual observations) so that other observers can observe, weigh or measure the same phenomena and check out observation for accuracy. Is there a God? Is Varna' system ethical or questions pertaining to the existence of soul, heaven or hell are not scientific questions because they cannot be treated factually. The evidence regarding their existence cannot be gathered through our senses. Science does not have answers for everything. It deals with only those questions about which verifiable evidence can be found.

Ethical Neutrality

Science is ethically neutral. It only seeks knowledge. How this knowledge is to be used, is determined by societal values. Knowledge can be put to differing uses. Knowledge about atomic energy can be used to cure diseases or to wage atomic warfare. Ethical neutrality does not mean that the scientist has no values. It here only means that he must not allow his values to distort the design and conduct of his research. Thus, scientific knowledge is value-neutral or value- free.

Systematic Exploration

Scientific research adopts a certain sequential procedure, an organised plan or design of research for collecting and analysis of facts about the problem under study. Generally, this plan includes a few scientific steps—formulation of hypothesis, collection of facts, analysis of facts (classification, coding and tabulation) and scientific generalization and predication.

Reliability

Scientific knowledge must occur under the prescribed circumstances not once but repeatedly. It is reproducible under the circumstances stated anywhere and anytime. Conclusions based on casual recollections are not very reliable.

Precision

Scientific knowledge is precise. It is not vague like some literary writing. Tennyson wrote, "Every moment dies a man; every moment one is born", is good literature but not science. To be a good science, it should be written as: "In India, according to the 2001 census, every 10th second, on the average, dies a man; every 4th second, on the average, an infant is born." Precision requires giving exact number or measurement. Instead of saying "most of the people are against love marriages," a scientific researcher says, "Ninety per cent people are against love marriages".

Accuracy

Scientific knowledge is accurate. A physician, like a common man, will not say that the patient has slight temperature or having very high temperature but after measuring with the help of thermometer, he will pronounce that the patient is having 101.2 F temperature. Accuracy simply means truth or correctness of a statement or describing things in exact words as they are without jumping to unwarranted conclusions.

Abstractness

Science proceeds on a plane of abstraction. A general scientific principle is highly abstract. It is not interested in giving a realistic picture.

Predictability

Scientists do not merely describe the phenomena being studied, but also attempt to explain and predict as well. It is typical of social sciences that they have a far lower predictability compared to natural sciences. The most obvious reasons are the complexity of the subject matter and inadequacy at control etc.

THE CONCEPT OF TECHNOLOGY

The term technology comes from two Greek words: *tehno* and *logos* (science). It is a science to the sum of knowledge about procedures and processes used in the manufacture of material production. Technology, in a lay man's understanding consists of manufactured objects such as axes, arrow heads, and their modern equivalents for the purpose of either to enhance human capabilities or to aid humans to perform tasks they could not otherwise perform. But technology is more than that. It requires a larger system including hardware (such as machinery or a manufacturing plant), factor inputs (labor, energy, raw materials, capital), and software (know-how, human knowledge and skills). The latter, for which the French use the term technique, represents the disembodied nature of technology, its knowledge base. Thus, technology includes both what things are made and how things are made.

Technology simply means the invention of both material and immaterial tools in order to solve real-world problems. Technology is also the sum of techniques, skills, methods, and processes used in the production of goods or services or in the accomplishment of objectives, such as scientific investigation especially in industry. Little wonder why technology replaces human workers with mechanical or electronic devices. An example is in the case of ATM (Automated Teller Machine) in the banking industry. Finally, it makes use of fewer resources to manufacture goods more efficiently. Technology concerns itself with understanding how knowledge is creatively applied to organized tasks involving people and machines that meet sustainable goals (Arthur, 2009).

Three things to learn from this definition are:

1. Technology is about taking action to meet a human need rather than merely understanding the workings of the natural world, which is the goal of science. An example is the invention of Microscope.
2. It goes beyond the use of scientist knowledge to include both values as much as facts, practical craft knowledge and the practical knowledge. The invention of iPod is an example of a small device accommodating much music with creative design.
3 It covers the intended and unintended interactions between products (machines, devices, artifacts) and the people and systems that make them, use them or are affected by them through various processes.

Technology is a hands-on thing and it involves skills like engineering, communicating, designing, developing, innovating, managing, manufacturing, modeling and systems thinking. It also has its proms and corns (Arthur, 2009).

Characteristics of Technology Evolution

Technological evolution is neither simple nor linear. Its four most important distinctive characteristics are uncertain, dynamic, systemic, and cumulative. These are briefly explained below.

I. Technological uncertainty derives from the fact that there always exists a variety of solutions to perform a particular task. It is always uncertain which might be best, taking into account technical, social and economic criteria. Technological uncertain type vials in all stages of technological evolution right from initial design, through success or failure in the marketplace, to eventual environmental impact and spin-off effects. According to Arthur (2009) since uncertainty will always persist, the correct strategy to forecast technological change is to also experiment with technological variety.

ii. Technology is dynamic and keeps changing all the time. Change includes a continuous introduction of new varieties and continuous subsequent improvements and modifications. The main factors governing technology dynamics are, first, the continuous replacement of capital stock as it ages and economies expand and, second and most important, new inventions.

iii. Technological evolution is systemic and cannot be treated separately. A new technology needs not only to be invented and designed, but it needs to reproduce with other technologies. It also requires infrastructures. For instance, a telephone needs a telephone network; a car needs a road network. This interdependence of technologies causes enormous difficulties in implementing large-scale changes. Though this is what causes technological changes to have such persistent and extensive impacts once they are implemented. These mutually interdependent and cross-enhancing socio technical systems of production and use cannot be considered in terms of single technologies, but must be considered in terms of the mutual interactions among all contemporary technological, institutional, and social change.

iv. Technological change is cumulative based on knowledge and previous experiences. Only in rare cases is knowledge lost and not reproducible. A new artifact, like a new species, is seldom designed from the scratch. Hence, technological knowledge and the stock of technologies in use grow continuously.

Phases in Technology Development

Joseph A. Schumpeter an Austrian economist (cited in Eneh, 2010) distinguished three important phases in technology development: invention, innovation, and diffusion.

Invention - is the first demonstration of the principal, physical feasibility of a proposed new solution. An invention is usually related to some scientific discovery, frequently measured through patent applications and statistics. However, an invention by itself often offers no hints about possible applications despite the technological nostalgia surrounding the inventor's human ingenuity. Even where applications are apparent, an invention by itself has no economic or social significance whatsoever.

Innovation - is defined is the point when a newly discovered material or a newly developed technique is being put into regular production for the first time, or when an organized market for the new product is first created. A distinction is frequently made between process and product innovations. Process innovation refers to new methods of production, while the product innovation refers to directly usable technological hardware, for instance, consumer products such as video recorders and compact disc players. It is an essential feature of the evolutionary character of technological change. Innovation is the implementation of creative ideas in order to generate value, usually through increased revenues, reduced costs or both. Innovation involves executing an idea which addresses a specific challenge and achieves value for both the company and the customer alike.

Diffusion - is the widespread replication of a technology and its assimilation in a socioeconomic setting. Diffusion is the final, and sometimes painful, test of whether an innovation can create a niche of its own or successfully supplant existing practices and artifacts. Technology assumes significance only through its application (innovation) and subsequent widespread replication (diffusion). Otherwise, it remains either knowledge that is never applied, i.e., an invention without subsequent innovation, or an isolated technological curiosity, i.e., an innovation without subsequent diffusion.

Incremental Innovation: Incremental Innovation is the most common form of innovation. It utilizes your existing technology and increases value to the customer (features, design changes, etc.) within your existing market. Almost all companies engage in incremental innovation in one form or another.

i. **Disruptive Innovation**: Disruptive innovation, also known as stealth innovation, involves applying new technology or processes to your company's current market. It is stealthy in nature since newer technology will often be inferior to existing market technology. This newer technology is often more expensive, has fewer features, harder to use, and is not as artfully pleasing. It is only after a few iterations that the newer technology surpasses the old and disrupts all existing companies. By then, it might be too late for the established companies to quickly compete with the newer technology.

ii. **Architectural Innovation**: Architectural innovation is simply taking the lessons, skills and overall technology and applying them within a different market. This innovation is amazing at increasing new customers as long as the new market is receptive. Most of the time, the risk involved in architectural innovation is low due to the reliance and re-introduction of proven technology. Though most of the time it requires some adjustments to match the requirements of the new market.

iii. **Radical Innovation:** This gives birth to new industries (or swallows existing ones) and it involves creating revolutionary technology. The airplane, for example, was not the first mode of transportation, but it is revolutionary as it allowed commercialized air travel to develop and prosper.

Differences between technology and innovation

Technology is the application of scientific knowledge (things known) for the purpose of practical application in industry. Technology involves the development of devices and machines from scientific knowledge already available. It involves a lot of different techniques that help to reduce efforts for example washing machines, smart phones, etc. Technology is something to which we adopt for our betterment and allows people to do different things at the same time. Current technology is the product of yesteryears innovation which has made life easier for the people.

According to Niosi (2008), innovation means being creative or inventive in solving a problem. This means the creation of new things, new methods, products, ideas or new ways of doing things which was not known earlier on. Innovation is something unique, new that has never been created or produced and will be released in the future so as to help to reduce workload for the people.

CHAPTER TWO

THE CONCEPT OF PUBLIC POLICY

The concept of public policy like many other concepts in the social sciences defy any universally accepted definition. Hence scholars have defined and or explained the concept from various perspectives. According to Dye (cited in Okereke, 1998) public policy is "whatever government chooses to do or not to do". It follows from this definition that it is not only in situations when government decides to take action about an issue do we have public policy but that it is also a policy position, if government decides to do nothing about a public problem. This is in line with Bachrach and Baratz's" decision" and non-decision" categorization of public policy.(Okereke, 1998).

Easton (1953, cited in Okoro, 2005:5) defines public policy as the authoritative allocation of values for the whole society. From Easton's definition, Okoro (2005:5) observes that only the government can authoritatively act for the whole society and whatever the government decides to do (or not to do) results in the allocation of values. Other very important definitions presented by Okoro (2005:5) are those of Kaplan (1970) who defines public policy as "a projected programme of goals, values and practices" and Sharkansky (1978) who asserts that policy can refer to a proposal, an on-going programme or the goals of a programme, major decisions *or the* refusal to make certain decisions" (Okoro, 2005:5).

Chandler and Plano (1988, cited in Okoro, 2005:5) see public policy as the strategic utilization of resources to alleviate national problems or governmental concern. The lack of consensus over the meaning of public policy according to Egomnwan (in Ezeani, 2006:289) derives from disagreement "over the public policy: should it be posited at the level of decision-making intention or action of the government". According to Adulsalami (in Ezeani, 2006:289), Public Policy "refers to hard patterns of resource allocation represented by projects and programmes designed to respond to perceived public problems or challenges requiring governmental action for their solution" Implicit in the above definition is that public policy is what governments actually do and not what they intend doing. In other words, mere declaration of intentions, wishes, principles, or expression of desires cannot be regarded as public policy. Scholars, who are also associated with this viewpoint include, Anderson et al (1975) and Sharkansky (1970).

On the other hand, there are scholars who regard declaration of intentions, wishes or proposed course of action as public policy. Dror (1967:14) defines public policy as a "major guideline for action". According to him, "Public policy, in most cases, lays general directives, rather than detailed instructions on the main lines of action to be followed".

Implicit in Dror's (1967) definition is the distinction between policy and decision. A policy usually has wider ramifications and longer time perspective than a decision. Policies provide the guiding framework for day-to-day decisions required in the application of resources (money, men and materials) towards the attainment of organizational goals (Nwosu, 1980). Again, Dye (1981:8) defines public policy as "whatever government chooses to do or not to do". A major flaw of this definition is its failure to recognize the divergence between what governments decide to do and what they actually do. The main weakness of the two sets of definitions discussed above is their failure to provide a basis for distinguishing policy formulation from policy implementation. Again, they failed "to provide any basis for evaluating the overall success or failure of policies as tn assumptions in the definitions are that each decision or action of government is supposed to be an independent policy of its own" (Egonmwan, 2002:2).

Public policy is seen as a proposed course of action, which the government intends to implement in response to a given problem, or situation confronting it. It is a statement of what government wants to do or what it will not do. Public policy can be regarded as general rules, regulations, guiding practices or actions in a particular activity or problem area (Victor, 1976:149-165). The special characteristics of public policy is that it is formulated by what Easton (1953) calls the "authorities" in a political system namely, executives, legislators, judges, administrators and the like (Ezeani, 2006:290).

NATURE AND CONCEPTUAL CATEGORIES OF PUBLIC POLICY

Anderson, (cited in Okereke, 1998:3) observes that "the nature of public policy can better be understood within certain conceptual categories". Okereke (1998:3-5) has identified these as follows

Policy Inputs/Demands

Policy inputs refer to all the demands or support on the system. In other words, policy inputs can come by way of demands or supports on the system. Policy demands "are those demands or claims made upon public officials by other actors, private or official, in the political system for action or inaction on some perceived problem". When a community requests for roads, electricity, or drinking water, such a community is making a policy demand on the political system. On the other hand, support refers to, and is illustrated by, a demonstrated acceptance of the authority of a government and its policies and programmes. A demonstrated support for a government assures it of its acceptance and legitimacy, and serves as an approval of this policies and programmes thus encouraging it to continue with such policies for which support is being given. Support can be given to a government through public show of solidarity, loyalty, obedience to law and/or compliance to policy, among other ways.

Policy Decisions

Policy decisions are series of decisions that culminate in public policy. These are "decisions made by public officials that authorize or give direction and content to public actions". Anderson (1975), points out that "included are decisions to enact statutes, issue executive orders or edicts, promulgate administrative rules, or make important judiciar interpretations of laws". In this sense, the decision by the Nigerian government to enact the environment protection policy is a policy decision. Similarly, the decision to adopt or not adopt free education is a policy decision.

Policy Statements

Policy statements are authoritative pronouncements of government indicating what government wants to do and how it wants to do it, to achieve an objective. Simply put, it is the "formal expressions or articulations of public policy" which include legislative statues, executive orders and decrees, administrative rules and regulations, and court opinions, as well as statements and speeches by public officials indicating the intentions and goals of government and what will bedoneto realize them. When government or its officials make pronouncements that have policy implications that is what is referred to as policy statements.

Policy Outputs

These are the policies that issues from government. It is the result of the synthesization of policy demands on government. It includes what the government does in response to a public problem. For example, if government provides water, electricity, roads, hospitals, etc., in response to public demands, these are policy outputs.

Policy Outcomes

Policy outcomes are the effect or impact of policy on the target population or society as a whole. In other words, policy outcomes are the overall intended and unintended, consequences of policy. For example, if government established hospitals as a policy output, the policy outcome will be the reduction in the number of people who get sick in the neighborhood or as a result of the establishment of the hospital. Similarly, if staff rationalization in the public services leads to reduction in government expenditure as well as enlarging the unemployment market, all of these constitute policy outcomes

PUBLIC POLICY ANALYSIS

Hambleton (cited in Okereke, 1998:3) sees policy analysis simply as a systematic investigation of a particular policy area . It is contended that this definition of public policy analysis is shallow and does not clarify much as to improve our understanding of the concept.

Clearly, Egonmwan, (quoted in Okereke, 1998) is more specific in his conceptualization of public policy analysis as he highlighted some of the activities that constitute analysis. He sees policy analysis as involving a systematic investigation of a particular policy area by means of "description, analysis and explanation of causes and consequences of public policy on the society through the use of scientific standards of inference."

Dye's (1981), view of public policy and policy analysis is illuminating and elaborate. According to him, the study of public policy or analysis of public policy involves a description of the content of public policy, an assessment of the impact of environmental forces on the content of public policy, an analysis of the effect of various institutional arrangements and political processes on public policy; an inquiry into the consequences of various public policies for the political system; and an evaluation of the impact of public policies on society, both in terms of expected and unexpected consequences. The non comprehensive and, perhaps, the more acceptable definition of public policy analysis is that presented by Quade (cited in Okereke, 1998), in his Analysis for Public Decisions. Quade (cited in Okereke, 1998), defined policy analysis as any type of analysis that generates and presents information in such a way as to improve the basis for policy makers to exercise their judgement". Elaborating further, Quade points out that policy analysis "encompasses not only its components but also the design and synthesis of new alternatives". Speaking specifically, he argued that policy analytical activities "may range from research to illuminate or provide insight into an anticipated issue or problem to evaluation of a completed programme. In most cases, policy analysis involves extensive accumulation of data through an elaborate application of quantitative methods (Okereke, 1998).

Anderson (1975) on his part identified three main concerns or focus of policy analysis, pointing out that: first, its primary focus is on the explanation of policy rather than on the prescription of "proper" policy. Second, the causes and consequences *of* public policies are rigorously sought for through the use of social scientific methodology. Third, an effort is made to develop reliable, general theories concerning public policies and their formation which are applicable to different agencies and policy areas. From what has been said so far, we can surmise that policy analysis is the critical but systematic examination of public policies and programs with the aim of determining their rationale, their consequences, feasibility and capacity to achieve or not achieve the intended goals or, if the policy is already: being implemented, to see if it is achieving its objectives or not and why. Two levels of analyses are deducible from the above definition. The first level is what we could call pre-adoption or pre-enactment analysis. The second level, we could call the post-adoption or post enactment analysis. Pre-adoption or pre-enactment analysis refers to that precedes policy adoption. It concerns the critical examination of public issues or problems and suggesting the probable best alternative course of action to be adopted to overcome or solve the problem. Once the problem has been identified, pre-adoption analysis would involve the following procedures recommended by Vaupel (cited in Okereke, 1998), for what he calls "complete analysis".

Generation and/or specification of all possible decision alternatives;
Prediction of all possible consequences of each alternative;

i. Estimation of the probability of each consequence Appraisal of the desirability of each consequence
ii. Calculating which decision alternative yields most desirable set of consequences.

Clearly, from the above, pre-adoption analysis is thus, the process in which policy issues are evaluated in detail to ensure that the right decisions and strategies for the implementation of such policy decisions are adopted. Pre-adoption analysis is necessary because policy decision-making involves choice situations and deals with the authoritative allocation of scarce resources. Post-adoption analysis, on the other hand, deals with the periodic and critical evaluation of an existing policy with the aim of determining the extent to which the policy has gone and/or its capacity to achieve its targets or not, on the basis of which the policy could be adjusted, reinforced, scraped or abandoned entirely. Post-adoption analysis ensures that a close monitoring of the policy implementation process is maintained so that the goal of policy is not defeated or derailed. This type of analysis could lead to policy redefinition, policy shift, policy expansion or contraction.

By policy re-definition, we mean the act of reviewing policy and its objective in such a way that it assumes new meaning, new direction and, perhaps, new impetus. On the other hand, policy shift refers to the act of re-focusing of policy on new issues and/or new problems in such a way that there is a shift from its original intention and/or objectives to new ones considered probably more relevant and more urgent Policy expansion refers to the process whereby an existing policy is expanded to assume more issues or accommodate more or problems. Policy contraction refers to a situation in which the scope of a policy is reduced to those issues that are unavoidable. It is the act of shedding off those that could be called "excess" loads - which post adoption analysis has shown to be unwanted and unnecessary. In both pre-adoption and post-adoption analysis, the analyst is usually cost-conscious. Policy alternatives that are likely to achieve objectives at the least cost are usually preferred. In policy analysis, the intended and unintended costs and benefits of the policy must, as much as possible, be identified and quantified as this will guide and determine what decision is finally made.

FEATURES OF PUBLIC POLICY ANALYSIS

Ezeani (2006:296) has explained the main features of policy analysis as follows:

Policy analysis is integrative and inter-disciplinary.

Policy analysis recognizes that policy problems are complex, with multiple causes and effects. It thus employs the skills of a wide range of professional disciplines and takes into account the social, environmental, foreign and intergovernmental impact of any given policy proposal (Beckman, 1977:22)

Policy analysis is anticipatory

Policy analysis focuses on decisions which are to be made, and also certain uncertainties surrounding us it may well identify new aspects of the issue under consideration and help to redefine it.

- Policy analysis is decision oriented. A good policy analyst presents the decision maker with an analysis of feasible decision options and their costs and benefits.
- Policy analysis could also be expo facto. This means that policy analysis can also be done after a policy has come into effect. This is often referred to as policy or program evaluation.

Effective policy analysis is value-conscious and client- oriented.

The policy analyst identifies for the decision maker the various stakeholders of particular options and the assumptions, values, or costs and benefit they would attribute to various alternatives (Beckman, 1977:222). This does not imply that the processes of policy analysis research are biased or value added. As Beckman (1977:222) rightly points out, a good analyst is aware of his or her own values and must be ready to factor them out of the dispassionate analysis provided to decision makers and their staff.

THE POLICY MAKING PROCESS

The policy-making process involves "a complex web of activities, interactions, techniques and strategies involving several persons, groups and agencies" (Ikelegbe cited in Ezeani, 2006:302). Various levels and stages of the policy process have been recommended by different scholars. Jones in Ezeani conceived five stages: problem identification, policy formulation, legitimating, application or implementation and policy evaluation. However, we shall here adopt the four main stages agreed upon by Ezeani (2006:303) and Okereke (1998:75), namely; problem identification, policy formulation, policy implementation and policy evaluation.

Problem Identification

A public problem has been defined as social need, deprivation or dissatisfaction, which affects many persons, and requires collective action (see Ikelegbe, 1996:73). A good example is the oil spillage and the consequent environmental degradation resulting from oil exploration and exploitation by the multinational oil companies in the Niger Delta areas. The Niger Delta people have been demanding for government policy to control or check oil spillage, and, for adequate compensation from the government through a policy of resource control. It is important to note that the articulation of a problem and the search for relief need not necessarily come from the affected people, through some level of awareness and desire for respite is expected from them.

Both the identification of the problem and the search for respite could be done by outsiders. Even when the problem is identified by the affected, the assistance of outsiders may be needed during the search for respite. For instance, the south-south geo-political zone has been wooing other zones in Nigeria to support their demand for resource control. The task of articulating and aggregating public problem is accomplished through organized pressure groups, individuals, political parties, political elites which ensure that the problems are ultimately represented on the policy agenda of the government. Policy agenda refers to public problems which the government intends to give serious attention in the present or in the future.

Policy Formulation

Policy formulation refers to the development of proposed courses of action for dealing with public problems. Existing studies of the policy process in several countries show that policy making is a complex exercise which involves a large number of actors. Lindblom (quoted in Richardson and Baldwin, 1976:127), for instance, distinguishes between "proximate" policy makers, and more remote policy makers and policy influencers. By "proximate" policy makers he refers to those who have legal authority to make public policies. Remote policy makers and policy influencers refer to persons, or group of persons, not within the orbit of the "proximate" policy makers, who influence and determine the content of public policies. This distinction of makers of public policies by Lindblom (quoted in Richardson and Baldwin, 1976:127), according to Okoye (1986:20) is very useful because, it goes beyond the parochial approach of associating policy-making with government departments alone, and further shows that a web of relationship exists between policy makers in government departments and those outside these departments but who in different ways influence policy making exercise to their advantage. The main factors involved in policy formation are: the legislature, the executive, administrative agencies/bureaucracy interest groups and the courts (Ezeani, 2006:304-306) 3. Policy Implementation. Policy implementation has been defined as "the activities that are carried out in the light of established policies" (Adamolekun, 1983:151). Initially, the emphasis on the literature on policy studies was on the policy formulation stage. Policy implementation stage was taken for granted. But this situation has changed policy implementation is now being recognized as a vital part of the policy process that deserves systematic study and analysis in its own right (Adamolekun 1983:146). Also, people are beginning to realize that implementation of public policies is not an automatic affair.

Adamolekun (1983:152) has identified the following subjects that deserve attention in a policy implementation situation: first; it is essential that the policy to be implemented is clear and specific; second, there is the question of the implementation organization, that is, the structure of the organization and the quality of its personnel; third, there is the question of the target group to be affected by the new policy to be implemented. Is the group organized? Is it an institutionalized group? What kind of leadership has it got? And finally, what is the nature of the environment within which the entire implementation process takes place?

It is important to note that the content of policy and its impact on those affected, may be substantially modified and elaborated, or even negated during implementation. According to Ezeani (2006:307-309) policy implementation involves the following actors: Administrative agencies or Bureaucracy, the Judiciary, interest or pressure groups, the legislature and community-based organizations.

Policy Evaluation

Policy evaluation is the last stage in the policy process. It is "concerned with the estimation, assessment or appraisal of policy, including its contents implementation and effects" (Anderson, 1975:51). Policy evaluation is crucial on because of the uncertainty surrounding the success of the implementation stage of public policy. As Barker (cited in Abulsalami, 1998:8) rightly observed, both the goals and means to achieve those goals have considerable inherent uncertainty, and therefore, there is no guarantee that any programme selected as a means for achieving goals is necessarily bound to be successful. It is important to note that policy evaluation can, and often does occur throughout the policy process and not simple at its last stage. Policy evaluation requires at the minimum, that the evaluator(s) knows what the policy is intended to achieve (policy objective), how we are trying to do it (programmes), and what has been accomplished towards attainment of the objectives (impact of incomes). There are the main sets of activities involved in policy evaluation: measuring output (performance measurement), comparing output performance against the desired results, and correcting any deviations or inadequacies (Adamolekun, 1983.155). Policy evaluation can be conducted by any of the following factors: policy makers, policy implementers, members of the public affected by the specific policy under consideration, and outside consultants or experts.

PROBLEMS OF POLICY EVALUATION

There are a number of obstacles to a successful conduct of policy evaluation. These have been identified and discussed by Ezeani (2006:311) as follows:

i. **Uncertainty over Policy Goals:** One of the problems encountered in the process of policy evaluation is the lack of clarity or diverse nature of the goals of a policy. This is a serious problem because it may make it difficult to determine the extent to which they have been attained.

ii. **Causality:** Another problem of policy evaluation is that of determining that changes in real life conditions emanate from certain policy actions. In other words, establishing a relationship between a policy and its impact or consequences. For instance, can reduction in crime rate be directly linked to government poverty eradication programme?

iii. **Diffuse Policy Impact: Every** public policy usually targets a certain group. Yet, the fact remains that a certain policy action may affect groups other than those which they are specifically targeted. For example, a welfare programme targeted at the poor may also affect other well to do members of the society.

iv. **Difficulties in Acquiring Data:** Dearth and sometimes nonavailability of data may hamper policy evaluation. This is usually the case in Nigeria, where relevant data are sometimes unavailable. This poses a serious problem to a policy evaluator who has no data to work within.

v. **Official Resistance:** Policy evaluation often results to indictment of certain government officials. Agency or program officials are, therefore, bound to resist policy evaluation if they suspect or fear that it will yield unfavorable results. They may discourage or disparage evaluation studies or refuse to provide relevant data to evaluators, or keep incomplete records.

SCIENCE, TECHNOLOGY AND PUBLIC POLICY-THE NEXUS

The relationship between science, technology and public policy is dynamic and multifaceted and can be briefly summarized as follows:

i. Scientific evidence and technological advancements guide public policy. Science and technology play a crucial role in shaping public policy. Policy decisions often rely on scientific evidence and technological advancements to inform and guide regulations, laws, and government actions. For instance, issues like climate change, healthcare, and cyber security require scientific understanding and technological innovation to develop effective policies that address these concerns.

ii. Science provides necessary information for evidence- based policies. Scientific research provides policymakers with the necessary information to identify and understand societal challenges, analyze risks, and assess potential benefits and impacts of various policy options. Scientific findings can help policymakers develop evidence-based policies that are grounded in empirical data and reliable research.

iii. Public policy gives direction to scientific research and technological development. On the other hand, public policy can also shape the direction of scientific research and technological development. Funding priorities, regulations, and incentives set by governments can influence the focus and pace of scientific discovery and technological innovation. Policy decisions related to intellectual property rights, patents, and industry regulations can impact the accessibility and commercialization of scientific and technological advancements.

iv. Additionally, public policy also establishes the legal and ethical frameworks within which science and technology operate. Policies may dictate limits on certain scientific practices, such as genetic engineering or human cloning, to ensure ethical norms and public safety. Similarly, regulations regarding data privacy, internet governance, and cyber security aim to protect the public and ensure responsible use of technology.

v. The relationship between science, technology, and public policy is iterative and evolving. Advances in science and technology lead to new policy challenges, which, in turn, necessitate updated policies to govern and regulate emerging technologies.

vi. Communication and collaboration between scientists, policymakers, and other stakeholders are essential to foster a constructive relationship that promotes evidence-based decision-making and responsible technological development for the benefit of society

CHAPTER THREE

TECHNOLOGICAL REVOLUTION

To every technological revolution there must be a profound impact on mankind's production patterns and lifestyles in order to adapt to the innovative environment. New technology does appear which provides the grounding for gradual changes that eventually transform our systems of production and the way we live our lives. Historically, we speak of these developments as technological revolutions. By focusing on how such technologies change the nature of work, occupational structures, environment, human life and systems of production.

The computing power in the few microprocessors that are now in a Ford Motor Car is much more than all the computing power that was put in the space vehicle that landed the first men on the moon and brought them back. But today' it mostly deals with business environment, by increasing demands from customers, shareholders, and regulators, the IT organization is not only asked to work harder and smarter, but is being asked to take on the role of assuring the business.

Many Americans feared that “the scientific and engineering research and development that the military-industrial complex channeled into the work of death stole resources from the civilian needs of a country struggling with industrial decline, social inequality, persistent poverty, and environmental degradation” (Pursell 299). Due to the prospect of misusing advanced science and technology to destroy and act violently instead of aiding the ailing nation, many Americans viewed innovation as cause for malevolent acts. Along with historical events, the changing ideas of development and progress after World War II led to the altering image of science and technology. Following World War II, there was an increased stress placed on transportation and urbanization coinciding with the period of technological evolution. This revolution in transportation led to the emergence and rise of automation. Automation is [in its most pervasive form] "anything significantly more automatic than previously existed obscured the technological basis of the change" (Pursell 287).

Humanity has progressed from agricultural revolution to the industrial revolution and is now moving to an information revolution. It is this awesome computing power at continuously falling prices and the computers being networked over global telecom highways that is leading to the use of Information Technology in every sector of human activity be it communication, banking, trading, learning and teaching, entertainment, health, security, socializing, government, management and library. Just as machines have extended man's mechanical power and his convenience and comfort, Information Technology as commonly picturized by computers, is extending man's mind or brain or intellectual power. The term information technology has ballooned to encompass many aspects of computing and technology, and the term is more recognizable than ever before. The technological Revolution began in Great Britain and many of the technological and architectural innovations were of British origin. Textiles were the dominant industry of the Industrial Revolution in terms of employment, value of output and capital invested. The textile industry was also the first to use modern production methods.

Technology refers to the application of scientific knowledge to the practical aims of human life or, as it is sometimes phrased, to the change and manipulation of the human environment. Revolution is a fundamental and relatively sudden change in already existing phenomenon. According to American philosopher Thomas Kuhn, technological revolution refers to a shift in technological paradigm. A technological revolution is a period in which one or more technologies are replaced by another, novel technology in a short amount of time. It is an era of accelerated technological progress characterized by new innovations whose rapid application and diffusion typically cause an abrupt change in society.

IMPACT OF TECHNOLOGICAL REVOLUTION

Intellectual/Educational Impacts: Technological revolutions give rise to a series of new theories, availability of research materials, new technologies and new methods as well as new disciplines, promote the change of the technology structure, and result in the shift of world science center. Since the 16th century, the world science center has shifted successively from Italy to the UK, France, Germany and the United States. A batch of Nobel Prize winners emerged from the second scientific revolution and the third technological revolution, becoming world-famous contributors to the progress of science and technology. Online debate, quiz and tutorials online classes during covid19 lockdown are examples of the above impact.

Social Impacts: Technological revolutions provide new ideas, new life and new knowledge for social progress such as scientific spirit, methodology and knowledge. People's lifestyle has been marked successively by machinery, electricity, automation and informatization. And people have experienced the change of life from a rural to an urban and then international one, from real to virtual one through social and wireless communication such as social media, creates denser social circles and also a rise in a leisure class.

Economic Impacts: Robert E. Lucas, Jr., says that the real effect of the Industrial Revolution was that "for the first time in history, the living standards of the masses of ordinary people have begun to undergo sustained growth. Technological revolutions provide new technologies and approaches for economic development, give rise to the emergence of new products and industries, change the industrial structure, employment structure and the focus of world economy, and are closely related to business cycles. The leading industry of the world economy has changed from agriculture to industry, services and then to knowledge. We have seen agriculture overtaken by industry, industry overtaken by services and then material industries overtaken by knowledge-based industries. It increases productivity, enhances marketing strategies and also multi-tasking of mass production.

Political Impacts: Through this revolution the government has been able to adopt e-governance pattern in order to enable the citizens to take part in public policy making and decisions taking. And this has promoted the principle of democracy and even participation in the matters of the state. Through this medium the citizens can express their worries to the government of the day in order for them to solve them. Technology promotes e-participations, e-Registrations,

Religious and Cultural Impacts: technologies have given birth to online worships, religious and cultural programmes, crusade, bible studies, cultural ceremonies on television and radio as well as prayers etc. all of these happens with the technology of this 21st century which most persons don't have to be present in the church or cultural center before been a beneficially or a witness.

Global Impacts: Technological revolutions promote Global networking and world modernization and provide national modernization with strategic opportunities. Countries grasping the opportunities are able to maintain or catch up with the world's advanced level of development; those ignoring such opportunities or failing to grasp them usually have mediocre performance and even suffer from the decline in international status (M.S. Newsletter 18 December 2011). Here modernization theory is required in order to follow the footsteps of developed countries on why, how, where, and when to apply this technology.

Health Impacts: In the modern world today, the impacts of technological revolution in health sector are numerous ranging from MRI scanners, Defibrillators Ventilators, Medical Apps and x-ray.

RELATIONSHIP BETWEEN WORLD MODERNIZATION AND SCIENCE AND TECHNOLOGY REVOLUTIONS.

World modernization is an objective phenomenon and global trend since the 18th century. Currently, there is no consensus on the definition of modernization yet. Generally speaking, modernization refers to the frontier change and international competition of human civilization since the 18th century including the formation, development, transformation and international interaction of modern civilization, the innovation, selection, dissemination and withdrawal of civilization elements, as well as the international competition and differentiation in catching up with, reaching and maintaining the world's advanced level of development. Between the 18th and 21st centuries, the frontier process of world modernization can be divided into two stages and six waves. The first modernization is the great changes and the transformation from agricultural to industrial economy and society and the second one from industrial to knowledge economy and society. The six waves refer to mechanization, electrification, automation, informatization, bionics and experiencing. According to M.S. Newsletter 5 December 2011, the third and fourth technological revolutions are marked by electronics and information technology respectively and separately (Qian, 2007). Some hold that the third and fourth technological revolutions can be together referred to as the "third technological revolution" (CAS, 2009). Some argue that the third and fourth industrial revolutions can be together referred to as the "third industrial revolution". Industrial revolutions refer to the great changes in the mode of production and industrial structure. S&T revolutions and world modernization are mutually reinforcing. For example, the first S&T revolution which took place in the 16th and 17th centuries prepared the scientific knowledge and approaches for world modernization and the first industrial revolution, marking the prelude to world modernization. The important inventions and innovations brought by S&T revolutions not only help to impel industrial revolutions but also are closely related to business cycles. Scientific, technological and industrial revolutions are both the embodiment and important components of world modernization.

STRUCTURES OF TECHNOLOGICAL INVENTION

The first technological revolution, marked by the invention of steam engine and machinery, was mainly about motive power technology (steam engine) and machine manufacturing (spinner and machine tool), and drove the development in such areas as coal, iron, metallurgy, petrochemicals and transportation. It lasted more than 120 years from 1698 when the first steam pump was made to 1825 when the first practical railway was built.

The second technological revolution, marked by the invention of electric generator and internal combustion engine, was mainly about power technology (electric generator and electric motor), transportation technology (internal combustion engine) and telecommunication technology, and drove the development in areas such as steel, petrochemicals, automobile, aircraft, electrical appliances, etc. It lasted more than 70 years from 1832 when the electric generator was invented to 1906 when radio broadcasting was invented.

The third technological revolution, marked by the invention of computer and the Internet, included two stages which were overlapped to some extent, i.e., electronics and information technology (M.S. Newsletter 10 December 2011). Both the revolutions in electronics and information technology consisted of the main areas and driven areas; and such driven or affected areas were broader than in the previous two technological revolutions, involving many fields of technologies. The revolution in electronics lasted a short span of time from about 1946 to 1970 while that in information technology will last longer from 1970 to 2020. The two stages together will last over 70 years, as long as the span of the second technological revolution.

To some content, the technological revolution and the industrial revolution are the two side of one coin, they may come together and maybe some different in the time of beginning and stop. The first technological revolution enjoyed the company with the first industrial revolution, second and third technological revolution with the second and third industrial revolution separately. The third industrial revolution is also named as the information revolution.

THE IMPACTS OF TECHNOLOGICAL REVOLUTION ON GLOBAL ECONOMY

It improves standard of living: Technology has deeply affected the global economy and its usage has been linked to marketplace transformation, improve the standard of living of the citizens and more robust international trade. So, if technology has virtually revolutionized every industry in the current global economy, why economists still question whether technology is visible in traditional economic metrics such as GDP, productivity, and corporate profits?

It reduces the cost of production and enhances productivity: Technological advances have significantly improved operations and lowered the cost of doing business. Currently, as an example, just a few technicians controlling robotic systems can operate an entire manufacturing plant, and innovative inventory systems are capable of supplying needed parts within a short time for assembly. Advancements in the computer industry, coupled with advancements in telecommunications, have increased job opportunities and strengthened economic growth.

It overcomes the physical barriers to communication: over distances have been properly overcome by the internet. In a similar way, manufacturing and consumer goods companies have developed online links to their suppliers and customer support. Suppliers can keep track of production line efficiencies through automated systems and can more efficiently ship parts and materials to the required locations, reducing inventory and downtime. In addition to that ecommerce and online banking capabilities have also helped reduce the cost of doing business. Many researches from many respected companies, such as BCG, IMF and World Economic Forum show that whenever companies cut back on technology investments aiming to shore up profits, the result is the opposite, as profits sink significantly, and, as a side effect, GDP also falls dramatically, then a chain reaction starts with the fall of labor productivity after a few years. As a matter of fact, what companies are really doing is cutting back on an important investment that could create the next growth wave and, in many instances, that investment could generate huge leverage, helping to lower costs and expenses much faster than technology spending rises, but companies can only achieve that by managing their technology spending properly. To do that, senior executives require new metrics and new ways of thinking. In order to successfully navigate the technology economics scenario and leverage optimum business performance, executives must create, measure, and track virtual economic measures just as carefully as they follow metrics about the physical world.

THE IMPACT OF NETWORKING ON GLOBAL ECONOMY

It builds relationships: No matter what type of business you have, you will always have competitors. With the global economy, you aren't simply competing with businesses in your area, but all over the United States and frankly, the world. With the flexibility and ease of conducting business online, business owners are faced with numerous competitors. Building relationships create business. When a consumer is making the decision of whom to do business with, they will feel more comfortable doing business with someone they trust, and therefore relationships matter.

It creates new avenues for your business: Business models can expire. Has yours been altered to match today's ever-changing economy and technology? Networking allows you to create new avenues for your business that your original model might not have considered or allowed for. Utilizing social media to introduce your business and products can expand your client base. If you aren't utilizing free services like LinkedIn, Twitter, Facebook or others, you are a step behind your competition. Stand out. When you're networking, it allows you to stand out. Potential clients can begin to put a name with a face. A successful networker will always be in front of their competition because they have made an impact; networking provides an opportunity for the impact.

It attracts and retain customers: Networking is a means for a business to tell their story. For example, it might be widely known that a salon styles hair and waxes, but it might not be as known that the same salon also does facials and massages. If you are not telling your story and explaining what you do, your business could remain stagnant. Networking provides a forum for introducing new services and products, which in turn captures new customers and educates existing ones. Knowing why networking is crucial is important, but understanding how to network is vital to your time and success. Below are three tips for success to be introduced in your method of networking.

It improves strategies: In today's fast paced climate, one can become overwhelmed with the amount of opportunities to network. Be strategic in planning where and how you spend your time. Select the functions and programs based on the most impact and effectiveness. You do not have to be everywhere all the time, but you do have to make choices to maximize the time you have.

CHAPTER FOUR

PRIMITIVE AND INTERMEDIATE TECHNOLOGY

Primitive technology is traceable to far North of Queens Land in the Australian State of Queensland and this demonstrate the process of making tools and building only materials found in wild. Although history of humanlike species does not help in fixing a precise point for its origin, because the estimates of Pre-historians and anthropologists concerning the emergence of human species vary so widely. Animals occasionally use natural tools such as sticks or stones, and the creatures that became human doubtless did the same for hundreds of millennia before the first giant step of fashioning their own tools. Even then it was an interminable time before they put such tools making on a regular basis, and still more an eon passed as they arrived at the successive stages of standardizing their simple stone choppers and pounders and of manufacturing them that is, providing sites and assigning specialists to the work. A degree of specialization in tool making was achieved by the time of the Neanderthals (70,000 BCE); more-advanced tools, requiring assemblage of head and haft, were produced by Cro-Magnons (perhaps as early as 35,000 BCE); while the application of mechanical principles was achieved by pottery-making Neolithic (New Stone Age; 6000 BCE) and Metal Age peoples (about 3000 BCE)

What is a Primitive Society?

The word 'primitive' comes from the Latin word 'primus' first, with the ending 'its virus' first of its kind. So, the original meaning could be prime, the first, which can mean best like prime rib. So, by that (not used now) definition a primitive society is the best society. Actually, primitive is a word not used by anthropologists today. It was a word used to replace negative terms like 'savage' and 'barbarian' (barbarian originally meant people that don't speak Greek, because to them foreign languages sounded like 'bababa). But primitive nowadays means people who are like our ancestors.

Primitive technology is defined as a hobby where someone builds things in the wild completely from scratch using NO modern tools or materials.
Examples of primitive technology and it processes are as follows:

Wood + fire = charcoal
Wood + stone + fire =axe
Wood + cordage + stone = bow and arrow
Snail shells + charcoal + pottery + fire =lime mortar.

IMPACTS OF SCIENCE AND TECHNOLOGY DURING THE PRIMITIVE AGE

Based on the most durable artifacts from prehistoric humans- stone tools- at first there was extremely little innovation for vast periods of time: hundreds of thousands of years. Then beginning about fifty thousand years ago, the sophistication and variety of stone tools shows a sharp upturn, such as arrow points and specialized stone tools for working wood and leather. Other artifacts evidence things like sewing and baking clay that we have no earlier examples of. So, it is thought that this era saw the dawn of sophisticated handcrafts. We also believe from how early humans apparently colonized Australia that it was by this time that the basic art of building canoes was devised.

Paleolithic (outdated) Hand Axes

Paleolithic hand axes were teardrop-shaped stone tools with two sharpened edges that met at a point. In one method, they were made by roughly chipping away flakes from the edges with a hammer and then sharpening the edges by chipping away smaller flakes. Finally, a pointed stick was used to pry off tiny flakes of stone. E.g., Wood + stone + fire =axe

Stone

The material that gives its name and a technological unity to these periods of prehistory is stone. Though it may be assumed that primitive humans used other materials such as wood, bone, fur, leaves, and grasses before they mastered the use of stone, apart from bone antlers, presumably used as picks in flint mines and elsewhere, and other fragments of bone implements, none of these has survived. Stones became tools only when they were shaped deliberately for specific purposes, and, for this to be done efficiently, suitable hard and fine-grained stones had to be found and means devised for shaping them and particularly for putting a cutting edge on them. These early tools were held in the hand, but gradually ways of protecting the hand from sharp edges on the stone, at first by wrapping one end in fur or grass or setting it in a wooden handle, were devised. Much later the technique of fixing the stone head to a haft converted these hand tools into more versatile tools and weapons.

Tools and Weapons

The basic tools of prehistoric peoples were determined by the materials at their disposal. But once they had acquired the techniques of working stone, they were resourceful in devising tools and weapons with points and barbs. Thus, the stone-headed spear, the harpoon, gun powder and the arrow all came into widespread use. The spear was given increased impetus by the spear-thrower, a notched pole that gave a sling effect. The bow and arrow were an even more effective combination, the use of which is clearly demonstrated in the earliest "documentary" evidence in the history of technology, the cave paintings of southern France and northern Spain, which depict the bow being used in hunting. The ingenuity of these hunters is also shown in their slings, throwing-sticks (the boomerang of Australian Aboriginal people is a remarkable surviving example), blowguns, bird snares, fish and animal traps, and nets. In addition, the Neolithic Revolution had contributed some important new tools that were not primarily concerned with hunting. These were the first mechanical applications of rotary action in the shape of the potter's wheel, the bow drill, the pole lathe, and the wheel itself.

Wooden Bow

A wooden bow, dated 5400–5200 BCE, was excavated from La Draga Neolithic site on the banks of Banyoles Lake in northeastern Spain in 2012. Some archaeologists contend that it is the oldest bow associated with the dawn of agriculture in Europe. Querns that ground grain by friction between two stones and, most complicated of all, irrigation techniques for keeping the ground watered and fertile all these became well established in the great subtropical river valleys of Egypt and Mesopotamia in the millennia before 3000 BCE. E.g, Wood + cordage + stone = bow and arrow

Building Techniques

Prehistoric building techniques also underwent significant developments in the Neolithic Revolution. Nothing is known of the building ability of Paleolithic peoples beyond what can be inferred from a few fragments of stone shelters, but in the New Stone Age some impressive structures were erected, primarily tombs and burial mounds and other religious edifices, but also, toward the end of the period, domestic housing in which sun-dried brick was first used. In northern Europe, where the Neolithic transformation began later than around the eastern Mediterranean and lasted longer, huge stone monuments, of which Stonehenge in England is the outstanding example, still bear eloquent testimony to the technical skill, not to mention the imagination and mathematical competence, of the later Stone Age societies.

INTERMEDIATE TECHNOLOGY

Intermediate technology simple and practical tools, basic machines, and engineering systems those economically disadvantaged farmers and other rural people can purchase or construct from resources that are available locally to improve their well-being. Designed to focus on people rather than machines, intermediate technology is considered to be more harmonious with the environment and with traditional ways of life. Intermediate technology requires human effort to accomplish a task.

Although intermediate-technology tools developed in conjunction with local residents are generally popular, there have been cases in which they failed to win over villagers. For example, engineers with a nongovernmental organization (NGO), Compatible Technology International, attempted to improve the lives of Guatemalan women who labored many hours to hand shell corn. The engineers produced a corn Sheller that consisted of a piece of wood with a hole in the middle. By pushing a cob of corn through the hole, the women could shave off the kernels far more quickly. The women preferred, however, to continue hand shelling corn, explaining to the engineers that they valued the time spent with one another more than the increase in productivity that the corn Sheller provided. Intermediate technology is relatively low, usually low labor- intensive technology that can be mastered by local people, especially in the developing world. Prior to the 1970's, we cannot say that poverty will be eliminated by job creation, because we still need a healthcare system, access to markets, and so forth. Bish reminds us that we need institutions for development, but while government is important, it cannot do everything on its own. Likewise, nongovernmental organizations (NGOs) play an important role, but are also not as effective if working alone. Organization is important, but it is more complicated than that. The examples of the technology are;

Rice Transplanter: These are technologies used for rice plantation.
Hand Borehole: This kind of technology requires continuous up and down process, by doing so water from the ground level is released.
Bicycle: It requires paddling to make it move.
Treadle Pump: this enables farmers to provide a greater amount of water to their plants which is more easily compared to watering by bucket, and it required much less infrastructure than constructing irrigation dams and pipes.
Corn sheller, Oil processing technology and
Spears: Spear is an example of an intermediate technology. In addition to short swords, Roman infantry typically carried a spear or other type of pole weapon. The most common was known as the javelin, a heavy spear that could be either thrown or trusted

Way Forward for Science and Technology in Africa Continent

The following recommendations will help to promote the development and advancement of science and technology in Nigeria and Africa in general:

i. Public policies should be projected and formulated to satisfy the general needs of society and not the selfish interest of a few wealthy ruling classes.
ii. Nigeria and African countries should accord more priority to science and technology infrastructure by increasing their budgetary allocation to education and research projects and programmes.
iii. The national science and technology policy framework in Nigeria should be reviewed to accommodate new ideas that will satisfy the immediate needs of the people through young scientists and gifted children who should be identified and nurtured through, scholarships and others incentives.
iv. African countries should also ensure that they carryout electoral reforms to ensure that only credible and responsible citizens are allowed to participate in the electoral process. This will greatly reduce corruption and mediocrity in the system.
v. To ensure sustainable national development, African states and its leaders should develop an indigenous development framework and methods.

vi. Local entrepreneurs and industrialists should be assisted with facilities to enable them compete favorably with their foreign counterparts in the international markets. This is imperative because Africa's growth and development agenda must be championed by Africans and not foreigners.

CHAPTER FIVE

HISTORY OF TECHNOLOGY IN INDUSTRIAL DEVELOPMENT

Technology and technological progress have played an important role in development of human kind. This unit will evaluate the historical perspective of technology development in major economies from two perspectives: One account will take into consideration developments in terms of industrial revolutions. The second account involves historical perspective of catch-up process among countries related to technological changes in production process, in innovation and invention process, and developments that influenced further increases of expenditures for science and technology.

Industrial Revolutions and Technological change.

Industrial Revolution marked the era when the society broke through from agrarian society to industrial domination. The First Industrial Revolution is a product of the eighteenth century. It encompasses variety of innovations, especially in the cotton industry of England. It was the time of transformation from handicrafts to factory system of production. The very important effect of the Industrial Revolution was that it was self- sustainable, unlike the situation before the Revolution, where any improvement in conditions and opportunities were dampened by the increase in population, thus keeping income in the low-level equilibrium trap (Malthusian trap). It is important to note that technological advancement made it possible to escape from the Malthusian trap where rising population matched or even outstripped growth in output, thus preventing any rise in GDP per capita. At this point Britain was able to accommodate population growth of up to 1.5 percent annually, unlike before 1700, where population growth above 0.5 caused real wages to fall. At the same time Britain became the richest European economy. Second, Britain went through a period of rapid structural change in employment. The change was towards much urbanized and industrialized labour force than in any other relatively advanced country (Crafts, 1998).

The common view of the industrial revolution is as a transition in which directions and possibilities of economic life were transformed enabling dramatic demographic challenges to be defeated over the long term. The changes involved here were complex and costs were considerable, both in the long and short run. However, the progress depended on new standards of economic efficiency, i.e., Productivity growth. Attitudes, perceptions and Understanding of production methods and opportunities were central to the process (Hoppit, 1990). Although England was on the forefront of industrial revolution, other industrial nations in Europedidnotlagbehind.In1785, Britain was still easing, however, the lead over France in the volume of output per capita from mines and manufactures was not as significant as fifty years before. Situation with the use of machinery and large furnaces and prevalence of large privately owned enterprises is much the same as for mines and manufactures in 1785 (Nef, 1943). It is obvious that the lead of Britain was not always progressing at the same pace. Continental Europe followed the pace and narrowed the gap between the leader and the followers. It seems that the rate of economic change in France during the most of eighteenth century was not less remarkable as that of Britain. Although the concentration of technology and technology change is mostly attributing to the manufacturing industry, the technological change in agriculture was not unimportant. The agricultural productivity in Britain in eighteenth century rose but not as much as in industry. Historians even point out that mobility of labour and capital, essential to industrial growth, were made possible due to social and economic improvements in agriculture. In the countries industrializing today, especially in Asia, even though industrial sector has increased production more rapidly than agriculture, output in agriculture has a steady rise and incomes in the rural areas have improved as well. Successful land reforms in Korea and Taiwan, unlike Latin American countries, were a very significant factor in the subsequent growth and development performance (Freeman & Soete, 1997). Mokyr (1990) argues that innovations associated with the industrial revolution should be seen as “macro inventions”. It is suggested that these are unpredictable, exogenous shocks that lead to advances in respective sectors. On the other hand, “micro inventions” are generated through subsequent improvement, adaptation, and diffusion of technology, commonly involving learning by doing and learning by using. Much of the productivity increases can be attributed to the later.

There are several possible factors that may have influenced low TFP growth (and R&D) in the early nineteenth century Britain. Smallness of markets, weakness of science and formal Education, inadequacies of the patent system, the continued high rewards to rent seeking, and the difficulties of securing compliant behavior on the part of workers may have contributed to the slowdown to a certain level. As far as the government is concerned, its policy did not play an active role in correcting failure or in any other way did it intervene to correct market failures compared to the successful government role in the Asian success stories like Korea, and Taiwan. The policy had quite the opposite role. This was viewed in the crowding out effect of public spending during the Napoleonic Wars. Interestingly, the ongoing transformation of economies after the first industrial revolution is labeled the second industrial revolution. Just as the first industrial revolution, the second one is continuation of development started by the first revolution. As mentioned earlier, these processes are more evolutionary than revolutionary. The innovation and inventions have emerged, but diffusion of the same is a much slower process. The beginning of the Second Industrial Revolution is labeled with several distinctions in comparison to time before the revolution. These differences were given through three different ideas. First, the accounting got an improved role. From mere record of past events, it developed into an applied science to help business decision-making. Secondly, engineers applied the results of pure science in order to get higher safety and economy in the construction of bridges and other works, and ships and boilers. The old methods, which included the rule of thumb and trial and error, were substituted with precise calculations and measurements. These new methods were of great importance in electrical engineering and slowly spread through mechanical engineering. Thirdly, there was constantly increasing competition among manufacturers and widening markets. The application of scientific ideas for the workshop along with the cost accounting represented a birth of scientific management.

There was an important shift here regarding the scientific methods. During the first industrial revolution much of the innovations and inventions were based on trial-and-error methodology, and on the rule of thumb. As economies and operations developed, this methodology was not sufficient any longer. Development of science introduced laboratories both in public and private domain. These laboratories were either merely for testing materials, or for research. A very important distinguishing characteristic of the second industrial revolution is the professionalizing industry. Functions, e.g., administrative, technical and managerial, are clearly distinguished along with the recognition of the qualification requirements for certain positions. The exploitation of technologies associated with the Second Industrial Revolution continues today. Major innovations and inventions (e.g., internal combustion engine, electricity, etc.) are still in use today with some improved features. However, main principles and ideas are the same. The "New Economy" associated with advances in information and communication technology (ICT) is sometimes associated with transference of economies from industrial to information societies. However, advances made by using ICT are far from benefits associated with the two industrial revolutions and hence could constitute the next industrial revolution.

History of Technology Development in Nigeria

Nigeria is blessed with different ethnic groups each having their indigenously developed usable technologies suitable for their own way of life and environment. Taking a look from the coastal communities and the riverine areas down to the hinterlands, highland and the Sahara Desert, people have developed and put into use local technologies suitable for their occupations, culture and transportation mode. However, it is not surprising to find that despite these differences, the peoples have common technologies. For instance, the hoes and tools used on farms, the canoe water transportation, the palm wine tapping procedure, the use of town crier or big drum as a means of communication, use of locally made bows, guns and arrows as means of defense and hunting, etc.

Technological development in developing countries has always been part of human existence though crude at the initial stage but has transformed into a celebrated phenomenon in the present age. Technology has been involved in the way man perceive his immediate environment, the means of livelihood especially in solving health care issues, dissemination of information and retrieval system and how to defend himself reveals the various levels of the scientific and technological approach to solving life's problems and challenges. Nigeria has no doubt played a worthy role in the various technological discoveries which largely influenced the global world.

The body that officially directs technology drive in modern Nigeria is the Federal Ministry of Science and Technology under the federal government and is saddled with the responsibility of facilitating the development and deployment of innovations, science and technology so as to enhance the pace of socio-economic development in Nigeria (Onipede, 2010). The Federal Ministry of science and technology was established on the 1st of January, 1980 by act Number 1 of 1980, as the successor organ of government to the National Science and Technology Development Agency (NSTDA), which was created in 1976. By January 1984, the ministry was merged with the Federal Ministry of Education which was then renamed, Federal Ministry of Education, Science and Technology. But in 1992, the ministry was scrapped and all the parastatals and research institutes were shared among other Ministries and Agencies such as the Federal Ministries of Industry, Agriculture, Health and National Agency for Science and Engineering Infrastructure (NASENI). The NASENI was established as an arm of government for the formation and implementation of science and technology policies and this later led to the formation of the Science and Technology Unit (STU). In 1993, the Federal Ministry of Science and Technology was again re-established and the STU under the presidency became the nucleus of the new Ministry. Consequently, some of its research institutes previously transferred to other Ministries was returned to operate under its purview. The Ministry is said to be currently supervising 17 Research and Development Institutions and interfacing with other cognate bodies to diversify the economy.

CHAPTER SIX

TECHNOLOGICAL CHANGE AND TECHNICAL PROGRESS

Technological progress has many dimensions. It could mean larger quantities of output, production of new and better products or the production of a larger variety of products. Technological progress leads to increase in output for given amounts of capital and labor.

The Production Function

Production function shows the relationship between the quantity of output and the different quantities of inputs used in the production process (Alani, 2012). In other words, it means the total output produced from the chosen quantity of various inputs. Therefore, it is a technical relationship between inputs and outputs. In the cause of technological progress, new inventions may result in the increase of the efficiency of all methods of production. Equally, some techniques may become inefficient and obsolete and will not be useful in production anymore. These changes constitute technological progress. This technological progress can be shown in a diagram with an upward shift of the production function or a downward movement of the production isoquant. Figure1a shows that the same output maybe produced by less factor inputs, while Figure 1b shows that more output maybe obtained with the same inputs. Technical progress also changes the shape of the is quant. According to Hicks, there are three types of technical progress depending on its effect on the rate of substitution of the factors of production.

Capital-Deepening Technical Progress

When the capital-labour (K/L) ratio is constant and the marginal rate of substitution of labour for capital (MRSLK) increases, it is assumed that technical progress has capital- deepening. The implication is that technical progress increases the marginal product of capital by more than the marginal product of labor. Therefore, the ratio of marginal products (MRSLK) decreases in absolute value. Since the slope of the is quant is negative, the technical progress in this case increases the MRSLK. The slope of the shifting is quant becomes less steep along any given radius as shown in figure.

Labour- Deepening Technical Progress

A situation where along a radius through the origin with constant K/L ratio, the MRSL.K increases, then we can say that the technical progress is labour-deepening. This means that the technical progress increases the MPL faster than the MPK. Thus, MRSL.K which is the ratio of the marginal products $[(\partial X/\partial L)]/[\partial X/\partial K)]$, increases in absolute value (but decreases if the minus is taken into consideration). The downwards-shifting isoquant becomes steeper along any given radius through the origin.

Neutral-Technical Progress

Technical progresses are neutral if it increases the marginal product of both factors by the same percentage, so that the MRSLK (along any radius) remains constant. The isoquant shifts downwards parallel to it.

The Role Technological Progress in Economic Growth

Traditionally economists view the process by which goods and services are produced as one that combines capital, labour, and other factors of production using a particular technology. The relative efficiency with which an economy produces goods and services with a given level of capital and labour is referred to total factor productivity (TFP) in other words a measure of technical progress. But, the relationships between income growth, technological progress, capital accumulation, and welfare are, of course, much more complex than can be summarized in a simple measure of TFP, partly because each factor of production and the technology with which factors are combined are dependent on one another. Even though measures of TFP and its progress give us a sense of the relative dispersion of technological progress, they tell us little about the mechanisms by which Technology influences development. Technological progress involves much more than doing the same things better or with fewer resources. It is more dynamic, involving both the creation of new products and production techniques as well as the spread of these techniques across firms and throughout the economy. Technological progress is beneficial to developing countries, it can also be disruptive. While the mechanisms by which technological progress contributes to socioeconomic development are in some sense obvious, the following deserve special mention (Arthur, 2009):

Technological progress in one sector can create new economic opportunities in other sectors: Lower production costs can create whole new products, or even sectors. A new-to- the-market innovation in one sector can result in a flowering of activity in other sectors by creating a demand for and supply of goods and services that did not exist previously Success in one activity may well lead to further innovation and technological deepening. The move from producing carnations to more fragile and expensive roses is an example. Another example is the shift to higher-quality products such as chilled rather than frozen fish fillets. Yet another example of deepening is palm oil production in Indonesia, where new processes include the production of new varieties of palms; the introduction of new crude and processed palm oil refining technologies; and, notably, the introduction of oleo chemical technologies.

The benefits of a new technology can extend well beyond the immediate sector in which the technology exists: This is the case if the initial product is an important intermediate good in the production of other goods, for example, telecommunications or reliable electrical service.

Technological progress can yield improvements in quality products: Such improvements can enable a developing country to penetrate more demanding consumer and intermediate markets. This can be as simple as employing machinery and equipment that produce goods and services that correspond to them or exacting expectations and standards of consumers and business clients in high-income countries. Technology in this sense extends beyond engineering technology to include management techniques.

Technological progress can spur development by lowering the costs of production and enabling the exploitation of increasing returns to scale: By improving the efficiency with which existing products are produced, new technologies can open up the possibility of increasing output and, assuming that markets are available, taking advantage of previously unexploited increasing returns to scale.

The disruptive nature of technological progress: The disruptive nature of technological progress can generate important benefits to society by spurring competition. For example, the introduction of mobile phone technology in several developing countries has introduced an important element of competition not only in the telecommunications sector, but al so in banking and other information-sensitive sectors. Hence, many of the informational asymmetry generated by lack of effective communications by middlemen used to exploit them has been eliminated.

CHAPTER SEVEN

ECONOMIC THEORIES OF TECHNOLOGY CHANGE

Traditional economists have viewed the relationship between technology and the economy as a one-way street. According to the neoclassical growth model of Solow (1956) and Swan (1956), shows how an economy reaches a steady state through the accumulation no capital. The steady state is where capital investment in each period is equal to depreciation. According to the endogenous growth theory technological change has a profound influence on our well-being indeed; the economy's long-run growth rate is determined exclusively by the rate of technological progress.

EXOGENOUS GROWTH THEORY

The initial neoclassical theory was developed by Solow in 1956 and then augmented by other scholars. According to the theory, sustained economic growth occurs through exogenous factor of production, that is, the passage of time. It is represented by the Cobb Douglas production function which relates output to factor inputs (stock of accumulated physical capital and labour). The theory imposes decreasing returns with respect to the use of each (reproducible) factor of production (and constant returns overall). The assumption shows that an increase in the stock of capital goods will result in a less than proportionate increase in output, if labour remains constant. Eventually more capital stock will produce no more output, resulting in lower profits and low output.

The neoclassical model states that in the long term, the growth rate of output per worker is dependent on the rate of labour-augmenting improvement in technology, which is determined by exogenous factor(s) not contained in the model. The model implies that all economies using similar technology will eventually converge to a stead state of growth. Though Solow remarked that "the steady state is not a bad place for the theory of growth to start, but may be a dangerous place for it to end". The Cobb-Douglas production function also known as the neoclassical production function, is expressed as follows:

$$Y = T \quad \text{where} + = 1 \qquad (1)$$

where: *Y*= output; *L*= labour; *K*= capital; *T*= time or the rate of technological progress which changes overtime.

The weights and represent the proportion of *Y* that accrues to labour *(L)* and capital *(K)* respectively. A simple Solow mode depicts the output, *Y*, of a business, as a function of three variables: capital, *K*, labour, *L*, and knowledge, *t*

$$Y = (AtL)^{1-} \qquad 0 \quad << \quad 1 \qquad (2)$$

Knowledge or technical progress is assumed to be independent of both the capital and labour inputs and to be a nonrival good, which is free for all businesses. It appears multiplicatively with labour in (1), denoting that knowledge contributes by "augmenting" labour and not affecting capital. The exponents and 1 – measure the relative contribution of the two inputs of capital and "effective labour". These exponents add to unity, to comply with the constant-returns-to-scale assumption for production.

According to Solow, the differences in productivity levels may be caused by faster/slower population growth or a higher/lower savings rate, while lower productivity could be due to climate deficiencies or other factors not accounted for in the model. This model has two important features which recent growth theories have challenged:

i. If people were to save a constant proportion of their income, capital per effective worker would be constant in the long run, so that $k' = 0$ and per capita income growth is therefore entirely determined by knowledge growth.
ii. Increasing the savings (i.e. investment) ratio could raise an economy's income level (permanently) by raising the growth rate of capital (and income) in the short run, but since the ratio of savings to income cannot continue to increase indefinitely, investment cannot cause income to grow permanently. Countries that invest more would be wealthier but would not grow faster since the only source of long-term growth is technical progress (or "knowledge accumulation"), which is assumed to

occur at an exogenous rate. According to this model, income growth rates are beyond business and government control, but, real- life experiences point to the contrary.

Endogenous Growth Theory

The endogenous growth theory which was developed by Romer (1986) and Lucas (1988), shows that conventional economics can be used to analyze the two-way relationship between technology and economics as well as the feedback effect from the economy to technological change. Technological progress is another form of capital accumulation because it consists of the accumulation of knowledge, inform of intellectual capital, much like physical or human capital. Technological knowledge, like other forms of capital, can be accumulated with the expenditure of current economic resources (R&D expenditures) and can be used to augment future production possibilities. In this theory, technological progress, like capital accumulation, arises from decisions to save. Some saving goes to finance the accumulation of physical and human capital, and some goes to finance the R&D that causes technological knowledge to accumulate. Thus, if the society saves a larger part of their national income, it leads to economic growth through increase of technological progress.

The new growth theory brought the endogenous technological change in to the mainstream of economics and revived interest in long-term economic growth as an objective of economic policy. The old theory presented a negative view of what economic policy could do in this regard, arguing that, in the long run, economic growth is limited by progress in physics, biology, and engineering, rather than by economic forces. But the new growth theory says that an economy's long-run growth rate depends on people's willingness to save, which is very much affected by economic policy. Moreover, standard cost-benefit analysis shows that a policy that produces even a tiny increase in long-term economic growth can generate benefits whose discounted present value are enormous. In the traditional endogenous growth theory, economic growth is likened to a private activity where economies can save to become richer just like private individuals. This simple theory will guide the developing countries in analyzing government policies that will affect national saving even though it ignores a critical social aspect of the growth process by being viewed as something that will raise everyone's standard of living.

This new theory emphasizes the distinction between technological knowledge and capital, and analyzes the process of technological innovation as a separate activity from saving. The new wave is explicit about who gains from technological progress, which loses, how the gains and losses depend on social arrangements, and how such arrangements affect society's willingness and ability to create and cope with technological change.

The Theory of Creative Destruction

One aspect of the endogenous growth theory was developed by Schumpeter, a development economist. The theory is called the *theory of creative destruction* because it involves a situation where each innovation produces new technological knowledge that improves our material possibilities and renders obsolete some of the technological knowledge that were originally created by previous innovations. Schumpeterian theory analyzes the process of technological innovation as being separate from saving. It highlights the difference between capital and technological knowledge. It sees economic growth as a social process bound up within situations, policies, social customs, and many other phenomena that affect not only the incentive to save but also the incentive to create new knowledge and the willingness to adapt to change.

The theory of creative destruction holds that it is innovation rather price that determines firms competition (Howett, 2007). It explains that the gains and losses of technological progress depend on social arrangements, and how such arrangements affect society's ability to create and cope with technological change. By this, the theory offers a new perspective on a number of important economic issues that interact with economic growth. Technically, a model of growth through creative destruction can be seen in terms of two long run relationships, that is, between the rate of economic growth (the growth rate of GDP per worker) and the amount of capital per efficiency unit of labour (efficiency units is measured by hours worked multiplied by productivity). An increase in the saving rate would result in a higher steady-state capital stock per efficiency unit for any given long- run growth rate. A higher rate of growth would imply a faster rate of technological progress, and hence a faster-growing labour force measured in efficiency units. The economy-wide level of R&D determines the flow of innovations, which, in turn, governs the rate of technological progress and, therefore, the long-run rate of economic growth. Given the constant institutional and policy variables, an increase in the steady-state capital stock per efficiency unit of labour raises the incentive to perform R&D through a "scale effect." That is, more capital per worker results in more production per worker, and hence more income per person, for any given level of technology (see Howitt and Aghion,1998). And when people have larger incomes, they spend more on newly invented products, which raises the incentive to perform R&D, and results in a faster rate of economic growth. Likewise, any changes in institutions, policies, or other variables that affect the incentive to perform R&D results in different rates of R&D and of long-run growth for any given capital stock per effective worker. According to this theory, the long-run growth rate is determined by strengthening the incentive to perform R&D and raising the economy's propensity to save.

CHAPTER EIGHT

ETHICS AND MORAL ISSUES IN SCIENCE AND TECHNOLOGY

Ethics are the principles, standards, guidelines, and codes of conduct that dictate what should or should not be done. Institutions, organisations and groups are governed by these ethical frameworks to ensure proper conduct.

Due to the critical nature of scientific research, adhering to ethical approaches is paramount. Without these ethical considerations, scientific research can have harmful and destructive effects on society (Soliman, 2021) and can erode public trust. According to Resnik and Shrader-Frechette (1996), scientific researchers have the following rights and responsibilities, which are considered principles of scientific research:

i. Conduct research and pursue knowledge.
ii. Assess the effects and consequences of research.
iii. Refrain from research with unreasonable risks to the public.
iv. Obtain informed consent.
v. Refrain from using public resources for research that translates to private profit.
vi. Conduct environmentally safe research.
vii. Remain unbiased in research.
viii. Ensure research is always for public good.

Additionally, ethics in scientific research encompass themes such as authorship, transparency, plagiarism, intellectual property, human and animal experimentation, conflicts of interest, funding, the intersection of science and business/military, data handling, and management. In summary, scientific research must always aim for the least harm and the greatest good.

Ethical Principles for Scientific Research

Over the decades, foundational texts such as the Nuremberg Code (1947), the

Declaration of Helsinki (1968), the Universal Declaration of Human Rights (1948), and the European Charter of Fundamental Rights (2000) have been developed. These texts together provide principles that guide scientific research, though some principles may be more relevant to certain scientific fields (Weinbaum, Landree, Blumenthal, Piquado, & Gutierrez, 2019). For instance, fields that do not involve human subjects may not be affected by principles like consent and beneficence. Broadly, ethical principles for scientific research can be categorised into those pertaining to the integrity of scientific research, the integrity of the researcher, and the researcher's duty towards the entity being researched. These principles include:

i. Duty to society
ii. Beneficence
iii. Informed Consent
iv. Integrity and Accountability
v. Conflict of interest
vi. Non-discrimination
vii. Non-exploitation
viii. Privacy and confidentiality
ix. Professional competence
x. Professional discipline

Moral and Political Issues in Science and Technology

Research in science and technology is not solely for the benefit of scientists; it has applications that resonate with the public and has a "social purpose" (Bhargava, 2006). There are moral and political dimensions in the application of science and technology, especially concerning human and animal subjects, and more so in developing economies where resources are limited.

Moral and political issues can sway the direction of research, its funding, and the regulations that guide it. Governments allocate substantial funds to research in science and technology and are deeply interested in how research and development are carried out and the potential applications and implications for society.

Examples of moral and political issues in contemporary research in science and technology include:

1. **Cloning and Genetic Engineering:** This area raises questions about identity, the nature of humanity, and the potential for eugenics, especially in contexts with limited regulatory frameworks.
2. **Artificial Intelligence:** The development of AI brings concerns about autonomy, job displacement, privacy, and the potential for AI to surpass human intelligence, with significant implications for labour markets and economic development.
3. **Biotechnology:** Research in GMOs, stem cells, and synthetic biology raises moral issues regarding health and food security.
4. **Funding and Prioritization:** This is a crucial issue, particularly for governments of developing countries. Funding decisions for research and development are heavily influenced by political and economic interests.
5. **Regulation and Control:** Regulatory policies can either foster or stifle innovation, impacting the development and application of new technologies.
6. **Access and Equity:** Ensuring that technological advancements benefit all segments of society and do not exacerbate existing inequalities, particularly in resource-limited settings.

Socially Responsible Research and Innovation

Science and technology should serve the public good, addressing critical societal needs without eroding public trust. Socially responsible research and innovation involve conducting research that benefits society and engaging with the public to ensure transparency and accountability. For research to be socially responsible, it should be transparent, engage the public, and be accountable.

Transparency: Involves open communication about the research goals, methods, and findings.

Public Engagement: Requires involving the public in the research process through participatory methods to ensure that research addresses community needs and concerns.

Accountability: Researchers must be accountable to the public, ensuring their work benefits society and minimises harm.

Society expects research and innovation to be responsible because research is often funded by the public. There are six pillars that form the framework for socially responsible research and innovation: public engagement, gender equality, science education, open science, ethics, governance

CHAPTER NINE

ROLE OF TECHNOLOGY IN SOCIAL AND ECONOMIC DEVELOPMENT

Technological change can contribute to social and economic development through the following ways:

POSITIVE IMPACTS OF TECHNOLOGY ON SOCIOECONOMIC DEVELOPMENT

Ending poverty and monitoring the progress of poverty alleviation programmes: One of the goals of sustainable development is ending poverty in all its forms and this requires not just income, but that, all peoples especially the poor and the vulnerable, have equal rights to economic resources, as well as access to basic services. Innovation and new technologies can contribute to the eradication of poverty by raising living standards and contributing to economic diversification. For example, renewable energy or solar technologies can be used to provide electricity in rural areas while internet can be used to detect water contamination as well as Purify the water. Also, machine learning and ICT can also be used to create measures, develop and monitor the effectiveness of anti-poverty programs and progress towards the Sustainable Development Goals. Models based on both mobile phone activity and airtime credit purchases have been shown to estimate multi- dimensional poverty indicators accurately (UNCTAD, 2016).

i. **Improvement in education**: New digital platforms, including open online courses, allow for open access and participation through the World Wide Web. The online technology does not just involve online video lectures but also incorporates social sharing features, interactive quizzes and assignments, supplementary resources (e.g., books, articles), community teaching assistants, etc. Technology has the potential of providing self-paced learning, lower cost quality teaching as well as good content and methods. Open hardware and software platforms have the potential to enhance the educational experience in developing countries. For instance, 3D printing is being used as a tool for education in primary, secondary, and post-secondary schools in developed countries.

ii. **Improving agricultural production and food security***:* It is estimated that about 795 million people are undernourished, with the majority living in developing countries and rural areas. With new and existing technologies, the issue of food in security can be addressed. There are basically four dimensions of food security, namely, food availability, access, use and stability. The use of irrigation technologies, improvement of soil fertility and use of genetic modification can help to increase food availability in developing countries. The issue of food accessibility can be solved using postharvest and agro-processing technologies, while the use of early warning systems can reduce the problem of instability in food supply. New technologies such as machine learning, is being used to detect soil and crop quality. For instance, in Nigeria, the use of technology has helped in building financial resilience to weather and climate changes that negatively affect the incomes of agricultural workers.

iii. **Technology helps to promote access to and efficiency of energy**: Access to electricity plays a critical role in improving livelihood, facilitating new productive and income-generating activities in an economy. The development of decentralized renewable energy systems can provide electricity in developing countries. Solar energy is presently used as an alternative means of generating energy in many parts of the world. Energy demand can also be managed with the use of big data technologies. Smart grids can increase energy distribution and production by allowing households with solar panels on their roofs to feed surplus energy back into the electricity grid. The real-time information provided by smart grids help utility companies to respond to demand for power supply, costs, and emissions as well as avert major power outages. For instance, Zenatix, a Delhi company, deploys smart meters and temperature sensors to monitor energy meters and help households and offices reduce energy consumption through message-based alerts. The transition from fossil fuels to renewable energy could be a catalyst for industrial development and structural change if backed by finance and investment, technology transfer and other supportive measures to ensure adequate energy supply at reasonable costs. Though such a transition requires overcoming important technological, economic, financial and governance obstacles in developing countries.

iv. **Enabling economic diversification and transformation, productivity and competitiveness**: For countries with requisite technological capabilities, technologies may support structural transformation, improve living standards, increase productivity and reduce production costs and prices. New technologies, including artificial intelligence, have the potential to promote new sources of employment and income and access new opportunities that were previously out of reach. New frontier technologies provide opportunities for technological advancement needed to restructure their economies. For example, a few countries such as the Republic of Korea and Taiwan have achieved rapid economic growth by advancing in some specific technology sectors such as electronic goods. Technologies, including artificial intelligence, have the potential to promote new sources of employment and income and access new markets and opportunities previously out of reach.

v. **Promote social inclusion**: New technologies enable large segments of populations in developing countries to innovate, coordinate, and collaborate. Grass-roots innovation facilitates the involvement of different networks such as academics, activists and practitioners experimenting with alternative forms of knowledge- creation and innovation processes. For example, a fabrication laboratory established by the University of Nairobi has used 3D printing to develop a sanitation solution for slums and a vein-finder device to help administer injections in infants. New platforms provide innovative ways to coordinate by distributing work, building two- sided markets for the sharing economy, and providing personalized digital learning within and outside established educational institutions. Digitally-enabled open and collaborative innovation enables knowledge and technology to be produced across a multiplicity of actors and institutions, drawing formal age pool from both formal and informal knowledge.

vi. **Improving the health status of individuals**: Technologies could address health challenges by distributing interventions, monitoring and assessing health-related indicators, and developing gene editing techniques. Countries are increasingly using geographic information systems and unmanned aerial systems to better connect citizens with existing health systems. For example, during a typhoid outbreak in Uganda, the Ministry of Health used data mapping applications to allocate medicine and mobilize health teams. For instance, in Rwanda, the government partnered with a robotics company, known as Zipline, to address maternal mortality by using drones to deliver blood to medical facilities thereby reducing the time needed to procure blood from four hours to fifteen minutes. New technologies hold promise for making public health interventions more effective by using big data and digital simulations for forecasting. Advances in biotechnology allows for specific gene editing for human medicine and personalized treatments.

Negative Impacts of Technology on Socioeconomic Development

While digital platforms may create opportunities for socioeconomic development in developing countries, digitalization may also present certain development challenges as identified:

Automation and future jobs: The application of new technologies provides an opportunity to address the development goals, but, they can disrupt economic development, thereby posing new challenges for policy makers and the society at large. Automation from the convergence of artificial intelligence, machine learning, and big data could impact employment, productivity, globalization, and competition in unclear and potentially negative ways. While technologies can be expected to create new jobs and opportunities, It also has the potential to disrupt existing labour markets and productive sectors. For example, the World Bank estimates, those two- thirds of all jobs could be susceptible to automation in developing countries in coming decades (UNCTAD, 2019). The impacts of automation varies according to arrange of factors such as the levels of industrialization and development, skills and capacities, labour costs, technological capabilities, infrastructure and policies encouraging or discouraging automation. Although jobs in developing economies tend to be less exposed to automation, developed and developing countries have started to converge in this regard in the last decades. Consequently, automation can have important impacts on the economies of developing countries in the future. Recently, new technologies have been substituting workers only in specific tasks, but they have not replaced entire occupations. Rather than eliminating occupations, technology changes how jobs are performed, and the number of humans needed to carry the mout.

Widen Income Inequalities: Despite the new opportunities for trade and development, dynamics could lead to widening income inequalities and increased polarization. The evolving digital connectivity has also been accompanied by online labour platforms that provide those with required skills new income-generating activities for people in developing countries. But there is fear that oversupply of job seekers online could reduce bargaining power and low wage rate.

CHAPTER TEN

INDUSTRIAL COMPETITIONS AND TECHNOLOGY CHANGE

Competition is the process of winning business in a crowded market. It makes production more efficient, cheaper and of better quality. Without competition, economic and technological progress or change will be slow or may not exist especially in developing nations. Technological change (TC) is the overall process of innovation, invention and diffusion of technology or processes. It derives from three major sources which are summarized as Research and Development (R&D), learning-by-doing and spillovers.

Industrial competition

Businesses that sell similar products or services are always competing with each other. For instance, if your business is education technology, your competitors are other businesses creating education tech apps. Industry competition is so fierce that companies have to fight for the business of potential customers. This could lead to a negative view about Competition. The state of industry competition can have a major influence on strategy even though competition has some negative implications. A product might be unique but it does not mean that there are no competitors for such product. As its growing, new competitors will definitely emerge. A competitive matrix can be a helpful tool for thinking through who your competitors are and how your product or service is different from theirs. There are five basic forces (Porter's Five Forces) that drive competition in an industry: Industry rivalry, threat of new entrants, bargaining power of customers, bargaining power of suppliers and threat of substitutes. They are:

i. **Industry Rivalry -** Industry rivalry describes a case of competitors within an industry jockeying for position, using tactics such as product launches, advertising competition, and price competition. When business owners feel competitive pressure or see an opportunity to improve their current position, rivalry can become intense. Sometimes it can even lead to industry disruption. The transportation industry in Nigeria is an example of industry rivalry.

ii. **Threat of New Entrants -** New industry players are always a threat to existing businesses. The seriousness of the threat, however, will depend on barriers to entry and there action from current competitors in the market place. If barriers to entry are low (example, if it costs little to enter the industry or if there are few economies of scale in place), new entrants can weaken the existing businesses' position in the market.

iii. **Bargaining Power of Customers -** Customers can affect the pricing. Prices are affected by how many customers purchase a product or service, how significant each customer is to accompany and the cost to a customer of switching from one business to another. If a company has a limited but powerful client base purchasing its product, they can often dictate their terms and drive prices down.

iv. **Bargaining Power of Suppliers-** If customers can drive prices down, suppliers can drive prices up. This force is driven by the number of suppliers, the uniqueness of the supplier's product, and how much it would cost a company to switch from one supplier to another. If a company has few suppliers, it becomes dependent on them and the suppliers in turn will have the power to increase their prices.

v. **Threat of Substitutes -** The demand for substitutes can reduce the demand for industry products and services. If a company increases its prices, customers are more likely to switch to cheaper alternatives. This can significantly reduce a company's power within the industry.

Competitive Parity

Competitive parity is the optimal expenditure on branding and advertising activities required for a firm to stay at par with the competitors of a particular brand, product. Promotional budget is allocated based on the scrutiny of optimal level of market competition. The war between Coca Cola and Pepsi is an example of such competition. The respective firms will first check their competitor' presence in any new place they want to establish their presence. Accordingly, they budget their advertising and promotional expenses. Businesses use competitive parity as a defensive strategy to maintain their reputation, brand and position without necessarily overspending on their financial resources. One of the merits of using this method to calculate the advertising and branding expenditure is that a business will not be too far away from competitors in the sense that their spending and visibility will be at par.

Another advantage is that it is more simplified than using sales forecast and demand forecast to determine what they will spend on branding and advertisement in the future. Though this can vary from one company to another depending on the situation on ground. For a company that is not doing so well financially, this kind of advertising and branding budgeting may not augur well for them. For new entrants into the market, this kind of budgeting is not always advised unless the market in itself is very new and still in its emerging stages in which case it makes sense as all the competitors are relatively new too. Hence; they will have to bear huge opportunity costs in order to match up to the budgets of existing firms in terms of advertising and branding. Similarly, for products that are different in nature, it is not worth spending exorbitantly on branding and advertising.

Two companies might have products that are competitors but they may also have products that are not competitive. A look at the advertising behavior of certain competitor's shows a fierce competition existing between them, including matching their spending on advertising and branding.

Competitive Advantage

Competitive advantage is the superiority gained by an organization/firm when it can provide the same value as its competitors but at a lower price, or can charge higher prices by providing greater value through differentiation. In other words, Competitive advantage is the leverage a business has over its competitors. It is also an attribute that allows a firm to outperform its competitors by offering consumers greater value, either by means of lower prices or by providing greater benefits and service that justifies higher prices. Other competitive advantage strategies innovators use to outdo their competitors are:

- **i. Brand***:* Brand loyalty is one of the biggest competitive advantages any business can capitalize on. An effective brand image and positioning strategy leads to customers becoming loyal to the brand and even paying more than usual to own the brand's product. Apple is a perfect example when it comes to brand-related competitive advantage.

ii. **Financial advantage***:* Some companies enter the market with huge funding and disrupt the system by providing some really enticing offers or providing the products at really low prices. This acts as a competitive advantage as other companies often fail to respond to such tactics.

iii. **Barriers to Entry & Competition***:* Businesses often make use of natural and artificial barriers to entry like government policies, access to suppliers, patents, trademarks, etc. to stop others from becoming a close competitor.

Competition Policy and Economic Growth

Competition tends to align private and social objectives. Given enough competition and the absence of externalities, markets should produce socially efficient outcomes, because firms that do not serve their customers efficiently will lose out to those that do. On the other hand, competition can reduce or even destroy long-run economic growth. This is because, in many cases, the main reward to a successful innovator comes in the form of monopoly rents that a firm captures by learning how to supply something its competitors cannot, or at a cost competitors cannot match. Increased competition, however, reduces a firm's ability to capture monopoly rents and discourages the innovations that trigger long- run growth. Indeed, this is what the first generation of Schumpeterian growth models predicted. Product market competition is good for growth because it forces firms to innovate in order to survive. Also, competition from a new technology drives improvements in previously developed technologies.

The Schumpeterian theory contains a variety of channels through which competition might, infect, spur economic growth. One of these channels is by creating barriers to entry which raises the cost of introducing a new technology to the outside firm. Invariably, this reduces both the incentive to perform R&D and the growth rate. Let us consider next the role of agency costs that allow managers to operate businesses in their own interests rather than maximizing the owners' profits. To the extent an increase in competition reduces the firm's flow of profits, it reduces the scope for managerial slack and forces managers to innovate more often.

Competition stimulates innovation by depriving managers of the opportunity to enjoy a quiet life. For firms that are already producing and earning profits, the incentive to innovate is lower, since innovations would affect existing profits. Despite this effect, incumbent firms might engage in at least some R&D if there were decreasing returns to R&D effort at the firm level. An increase in the intensity of competition tends to reduce the absolute level of profits a successful innovator realizes. It equally tends to reduce the profits of an unsuccessful innovator. Therefore, competition can have a positive overall effect on the rate of innovation, because firms will try to innovate in order to escape competition.

Another channel through which increased competition can stimulate economic growth is described in a model of fundamental and secondary innovations created by Aghion and Howitt (1996).The fundamental research is the basic research that generates the underlying ideas leading to new products. Meanwhile, secondary research is applied research or development that helps in the realization of the potential created by the fundamental research. In the Aghion and Howitt model, society faces a tradeoff between engaging in basic research or engaging in applied developmental research. Most times the output of fundamental research is more difficult for a private firm to appropriate because it is underprovided in the absence of government support to the extent that existing research is reallocated from secondary (applied) toward fundamental (basic) research. And an increase in the intensity of competition indeed leads to such a reallocation. That is, when new products can compete more freely with existing ones, someone who makes a basic innovation can attract developers more easily, which raises the returns to the basic innovation. Thus, more competition raises the rate of economic growth by encouraging a reallocation toward more fundamental research. To the extent competition policy authorities, regulators, or trade liberal users might have shrunk from promoting competition for fear that innovation-promoting profits might erode, the new growth theory suggests they should take a more aggressive stand in favour of more competitive markets.

CHAPTER ELEVEN

THE CONCEPT OF TECHNOLOGICAL TRANSFER

Technology developments are happening around the world and these new developments must be explored and adopted by those who developed the more acquired by those who need them. Technology can be acquired in two ways; either it is developed through research and development (R&D) or it is purchased by the person or country that needs it. Therefore, it is this second way of acquiring technology that is commonly referred to as 'Technology Transfer.' This is a process which is very crucial for the wide utilization, application and up-gradating of already developed technology.

According to Rani, Rao, Ramarao and Kumar (2018) technology transfer is the process of transferring scientific findings, knowledge, manufacturing process, etc., from one organization to another for the purpose of developing them further as well as for commercial purposes. Technology transfer enables the flow of technology from one source to another (receiver). The holder or owner of the knowledge is called the source while the beneficiary of such technology is the recipient. Technology transfer is a process by which various elements of technology are transferred from one individual or group to another for meeting the needs of the society

Classification of technological transfer

Technological transfer involves providing technology developed from one user to another user and it can be categorized differently as listed below:

i. International technology transfer is when technology is transferred across national boundaries. For instance, technology can be transferred from industrialized nations or economies to developing or emerging economies.

ii. Regional technology transfer is when technology is transferred from one region of the country to another. For instance, from one state to another state within the same country.

iii. Cross sector technology transfer (across industry) is when technology is transferred from one industrial sector to another. For instance, technology is transferred from agricultural activity to commercial activity.

iv. Inter-firm technology transfer is when technology is transferred from one firm to another. For instance, the transfer of computer-aided manufacturing (CAM) machines is being transferred from a machine tool manufacturing firm to a furniture producing firm.

Intra-firmtechnologytransferiswhentechnologyistransferredwithinafirm from one location to another. For instance, when technology from a particular company or firm in Abuja is transferred to another subsidiary in Suleja. It could also be from one department to another department that is within the same facility.

Stages of Technology Transfer Process

The transfer of technologies between countries especially from mostly developed countries to developing countries follows five different stages namely:

i. The first stage includes sales and licensing agreements which covers all forms of industrial property such as patents, industrial design, trademarks, investors' certificates, service names and trade names, etc.

ii. The second stage is the provision of technical expertise in the form of feasibility studies, diagrams, instructions, training, etc.

iii. The third stage is the provision of basic engineering designs, installation sand operations of acquired plants.

iv. The fourth stage involves leases and acquiring of machinery, intermediate goods (raw materials) and equipment.

v. The fifth stage involves industrial and technical cooperation agreements of any kind, international sub-contracting and provision of management and marketing services.

Technology flow Channels to Developing Countries

Technology can flow easily across countries, industries, departments or individuals so long as there are established channels of flow. The two channels through which technologies can flow from the source to the receiver are informal and the formal flows.

Informal Flows of technological Transfer are:
General channels: This is when technology is unintentionally transferred and may continue without the direct and continued involvement of the source. This could be in form of tourism, education, conferences and workshops, training as well as even publications.

Reverse engineering: This is when technology is transferred without going through the usual technology transfer process. It is mostly adopted by agencies and is the fastest route for duplicating an existing technology.

Formal Flows of Technological Transfer are,

This refers to the intentional transfer of technology from source to the receiver. It is also referred to as 'planned channels' because they follow a planned process so as to get the consent of the owner of the technology. The owner under different agreements then permits access to the receiver or user of the technology and they include:

i. Foreign direct investment (FDI) is where a multinational corporation decides to investor produce its products oversee as. This idea permits the transfer of technology to another country though the technology is still controlled by the firm. This type of investment becomes mutually beneficial to both the host economy and the investor. First, the host country gets technological knowhow, employment opportunities as well as training for the work force and investment capital that adds to the development of its infrastructure. The investor on the other hand gains access to natural resources, labour force, and markets for their products.
ii. Turn-key project is where a country (receiver) purchases a whole project from another country (source) and the project is designed, delivered and implemented ready to operate and use. There may be special provisions for training or continued operational support but that will be determined by both parties. This may be equivalent to selling or buying the machine.
iii. Technical consortium on joint R&D project is whereas country joins another country or more countries as a large venture, to affect the direction of technological change due to inadequate resources. Typically this type of venture takes place between two or more

countries or two large conglomerates. All these cooperative projects aim to advance research; develop technology and transfer of knowledge to participating member states. Here, the entities combine their interests, share knowledge and resources to develop a technology or a product or use their know-how to complement one another.

i. Licensing is when the receiver purchases the rights to utilize someone else's technology. It may involve a complete purchase or a payment of an initial lump- sum amount plus a percentage of sales.

ii. Franchise is a form of licensing where the sources usually provide some type of continuous support to the receiver. This is a channel commonly used in developing countries by the industrial educations when heavy technology is transferred. A few countries have encouraged joint ventures rather than FDI to maximize technology transfers to local firms. However, this strategy seems to work only for countries with substantial market power. In particular, fear of losing control overcutting-edge technologies sometimes causes multinational firms to be forced into joint ventures to reserve their best technologies for the domestic market and transfer only older less efficient ones.

TECHNOLOGY DIFFUSION AND ADOPTION

Diffusion is the spread of knowledge from an original source or sources to one or more recipients. Technology diffusion does not follow a single uniform pattern. The process of diffusion tends to last the longest in the innovation center, that is, region foreign. A region where diffusion begins later tends to have a quicker diffusion process as they "catch up" with the center of origin. The extent of diffusion within a region, the adoption level, tends to be highest in the innovation center. Diffusion times are shorter in the"catch-up"regions and adoption levels are generally also lower. For instance, countries where automobiles and railways were first introduced, took nearly 100 years to reach maturity. Late adopters began several decades later, but diffusion took only a few decades instead of an entire century. The timing of diffusion also sets the pace for pervasive technological change, i.e., the emergence of the sort of technology clusters that determine global change. Important technology clusters needed several decades to develop initially, and about half a century to reach maturity in the innovation centers and to diffuse at the international level. Altogether, the overall temporal envelope of any particular technology cluster spans up to a century, with its main growth period covering about five decades.

Drivers of Technology Diffusion and Adoption

The achievement of technological progress in developing countries can be attributed to the ability of the economy to absorb and adapt pre-existing and new technologies, rather than to the invention of entirely new technologies. Given that technology gap exists in developing countries; this situation is likely bound to continue.

A developing country's ability to absorb and adopt foreign technologies depends on two main factors:

i. The extent to which it is exposed to foreign technologies (the pace at which technologies diffuse across countries) and
ii. The ability to absorb and adapt those technologies to which it is exposed (the pace at which technology diffuses within the country).

The identified channels through which developing countries are exposed to foreign technologies so as to translate to technological achievements are:

International Trade: Trade is one of the most important mechanisms by which embodied technological knowledge (in the form of both capital and intermediate goods and services) is transferred across countries. Imports of technologically sophisticated goods help developing countries raise the quality of products as well as the efficiency with which they are produced. Countries can also absorb new technology by exporting to customers who provide guidance in meeting the Specifications required for access to global markets. For developing countries with low R&D intensity, trade openness and exposure to foreign competition provide powerful inducements to adopt more advanced technology in both exporting and import-competing firms and are likely to produce large technology spillovers and productivity gains (Schiff&Wang2006). The dismantling of trade barriers in many developing countries increased developing countries' exposure to foreign technologies.

Participation in high-tech export markets has also been identified as a channel through which technology is diffused within developing countries. Exporting firms in developing countries benefit from technological transfers that occur as a result of their interactions with foreign buyers who may have higher quality standards than domestic buyers. These foreign buyers may also assist with information, process improvements and experience with foreign markets.

It should be noted that the extent to which imported technology boosts domestic technological activity either directly or indirectly depends on the quality of a country's technological absorptive capacity. Also, the business climate may be too weak or the technological literacy of the local labor force may be too low to successfully adapt the machinery to local conditions. The country may not realize the potential productivity improvements available from imported technology.

Foreign Direct Investment (FDI)-Like trade, FDI can be a powerful channel for the transmission of technology to developing countries by financing new investment in machinery and equipment purchases, by communicating information about technology to domestic affiliates of foreign firms, and by facilitating the diffusion of technology to local firms. Foreign Direct Investment (FDI) includes mergers and acquisitions that may involve no additional physical investment, and the share of mergers and acquisitions, including privatization transactions. Foreign firms may also improve the technological capacity of developing countries by financing R&D. Foreign direct investment (FDI) may also affect the level of technology in domestic firms. Spillovers can arise when workers receive training or accumulate experience working for multinationals and then move to domestic firms or set up their own enterprise. In addition, foreign investors may provide advice, designs, direct production assistance, or marketing contacts to suppliers, which the latter can then deploy more broadly than simply providing cheaper or more reliable inputs to the foreigners.

The entry of multinationals is likely to increase competition for the domestic firms within the industry, potentially forcing them to improve their efficiency and introduce new technologies or business strategies (Blomstrom, Kokko, & Zejan 2000). Such competition can make surviving domestic competitors stronger, but other domestic firms may be driven out of business, lose market share, and experience a loss of high-skilled workers and higher costs for intermediate goods resulting from increasing demand from the foreign-owned firms. These effects may vary by industry depending on factors such as the market structure before the entry of foreign multinationals, the R&D intensity of the products, and the links between foreign firms and domestic firms in upstream and downstream sectors.

FDI is a major source of process technology and learning by doing opportunities for individuals in developing countries. In addition to dismantling barriers to foreign investment, some middle-income countries have encouraged greater FDI flows by implementing stronger regimes governing intellectual property rights.

International Migration: Substantial technology transfers are also associated with international migration of developing countries where the direction of technology transfer can be both outward (as migrants take away scarce skills) and inward (through contacts with the Diaspora). Though not all of these are positive. The direction and scale of technology flows that result from international migration is not as clear as that of FDI and trade. Developing countries can benefit from the immigration of managers and engineers that often accompanies FDI, they can also benefit from the technologically sophistication of the returns of well-educated developing country emigrants.

High rates of skilled out-migration imply a net transfer of human capital and scarce resources (in the form of the cost of educating these workers) from low- to high- income countries. Most university-educated individuals from developing countries, these days do not return to or remain in their country of origin, leading to the problem of brain-drain. The issue of brain drain is a serious problem for a number of mostly small countries because the better educated citizens of developing countries working in high-income countries contribute to that economy. On the other hand, the contribution that these individuals would have made had they stayed home is uncertain given the lack of opportunities in their home countries.

However, the existence of a well-educated Diaspora constitutes an important technological resource for the home country. For most countries, high-skilled outmigration remains at manageable levels and these knowledgeable Diasporas contribute to technology transfers by strengthening trade and investment linkages with more advanced economies through networks that provide access to technology, capital and through remittances. Remittances not only contribute to domestic entrepreneurship and investment, but also, along with the introduction of mobile phone services, have greatly expanded the provision of banking and other financial services within developing countries. Finally, returning migrants can provide important resources, such as entrepreneurship, technology, marketing knowledge, and investment capital. The effect of a single returning émigré armed with skills acquired in a developed economy can have (and has had) large economic and technological effects on the country of origin.

Direct Government Policy: - Good governance and business environment should focus on strengthening the infrastructure necessary for the successful diffusion and implementation of technologies, on facilitating the diffusion of already existing technologies, and on developing domestic competencies. Developing countries in most cases do not have blueprint for technological progress but most success stories have involved strong central leadership to ensure a consistent and effective policy framework that supports the development and commercialization of innovations.

I. Financing and Supporting Innovative Firms: - Developing is filled with more of informal sectors where technological progress is largely implemented by the private firms. However, progress at the firm level requires government support in form of an appropriate incentives framework, including overall political and economic stability and government transparency, along with specific technology policies such as protection of intellectual property rights; investments in human capital, including general education and technical training where firms under investing training because of the potential mobility of trained staff; support for R&D of new-to-the-market technologies because of difficulties in appropriating the full benefits from such efforts; and, where appropriate, government interventions to overcome market failures involving coordination, threshold effects, and agglomeration effects. Most technological success stories of countries such as Germany, Japan before and after World War II, the East Asian miracle countries, Chile, Ireland, and Israel have involved strong national leadership and a coherent strategy for promoting technology.

ii. Basic Technological Literacy: - The capacity of firms or individuals to use a technology depends critically on the basic technological literacy as well as availability of skilled labour. The level of technological literacy, depends on the government's capacity to provide qualitative education health, and publicly- provided infrastructure; in the procurement of goods and services; in the provision of information for the people.

CHAPTER TWELVE

ISSUES OF TECHNOLOGY ACQUISITION IN DEVELOPING COUNTRIES

The problem of technology transfer is related to certain issues which includes technology acquisition and the choice of appropriate technology. Technological development comes from R&D, from international organizations, etc. whatever be the case, every available sources needs to be explored when acquiring new technologies. The technology adoption model explains how accessibility and exposure play a role in technology adoption.

TECHNOLOGY ACQUISITION

One of the major issues in technology relates to the mode of technology acquisition. Developing new technology may come from different sources such as works of scientists, manufacturers and other industries, universities researchers who are working in R& D laboratories, governments and multinational corporations. Whatever may be the case, every source needs to be explored for ideas and new technologies. Each firm has specific sources for most of the new technologies. The question then should be how will the firm acquire new technology, is it going to be a "make or buy decision". In other words, should the firm develop the technology itself or acquire it from an outside source? The decision should be taken very carefully at this stage.

The acquisition routes of three stages are: (i) Internal (ii) External and (iii) Combined sources.

i. Internal technology acquisition through in-house creation - This is the result of technology development efforts that are initiated and controlled by the firm itself. Internal acquisition requires the existence of a technological capability in the company. Internal technology acquisition options have the advantage any innovation becomes the exclusive property of the firm.

ii. External technology acquisition- External acquisition is the process of acquiring technologies developed by others for use in the company. External technology acquisition generally has the advantage of reduced cost and time to implement and lower risks. However, the technology available from outside sources is generally developed for different applications. Therefore, external acquisition should contain an aspect of adaptation to the acquiring company's application.

iii. Combined sources – This is when technology acquisition involves a combination of both external and internal activities. The essence of using a combined acquisition is to take advantages of both internal and external sources and at the same time overcome the limitations of both.

Choice of Technology

The second major issue related to technology transfer is the choice of technology. It is argued that it is the industrialized countries that develop technology and know- how, thus whatever that is developed will be mainly useful to them making them become monopolists in developing, using and managing technology. This also means that the technologies tend to be designed for the production of high-quality sophisticated goods on a large scale, using as much as possible capital and higher-level professional skills in place of sheer. In carrying out technology transfer from developed countries to developing countries, care needs to be taken because if the technology content and level are not appropriate, the technology will be more harmful than good. Such "appropriate technology" raises several questions for the international/national managers, that is, to what extent or feasible alternative technologies are readily available? If not available, can the cost of developing more appropriate technology be justified? The issue of cost of the technology transfer is a very serious issue for developing countries. For instance, 90% of the modern technology transfers to developing countries are controlled by multinational corporations who are essentially interested in getting the highest returns from their inventions. Even, the developing countries reacted in their own way to face the restrictive clauses imposed by international business on their exports of technologies.

Creating Local Capability

Technology is not simply a blue print that can be transferred to any part of the world without the receiver putting any local effort. Creating local technological capability is essential to absorb imported technology. Each time some technology is installed some local adoption is required, which demands local technological capability. The need for local adaptation arises from the fact that the environment in which any technology operates is unique in a situation when it is installed. Difficulties are often found in the availability of skilled labour, the dexterity, training, education and experience, availability and quality of materials and components and infrastructural facilities including energy, transportation, water and communication. The local technological capabilities are also needed in order to adopt technologies to local conditions to improve productivity in the operations and to permit the attainment of international competitiveness and growth of exports.

Technology Acceptance Model (TAM)

Research on technology adoption and diffusion in developing countries focus mostly in Information and Communication Technology and they assume that technology is readily available, with the receiver or user deciding whether to accept or reject the technology (Musa, Meso & Mbarika, 2005). This assumption may not hold water because the developing regions such as sub-Saharan Africa lag behind in basic socioeconomic factors when compared to other regions of the world. Meanwhile these factors are very important for the day-to-day use of modern technologies (Meso & Mbarika, 2005). Therefore, to the users of ICT, adoption is not a matter of choice, since universal access and exposure to technology is not available. Access and exposure to basic forms of technology over a period of time gives room for application of a more advanced types of technologies to aid in human development efforts. Technologies adoption requires that economies should take in to consideration their cultural, historical land socioeconomic conditions at all times before acquiring the technology.

Gallivan, (2001) posit that some theories such as the theory of planned behavior, diffusion of innovations, social cognitive theory, and the technology acceptance model have been used to explain technology adoption and acceptance. One of the most referenced of these models is the Technology Acceptance Model (TAM) which suggests that successful adoption (acceptance) of technology is dependent on its usefulness and its ease-of-use (Davis, etal.,1989).

Technology Acceptance Model (TAM) was developed from the theory of planned behavior (TPB), of psychology research which centre on the theory of reason education (Mathieson, et al., 2001). TAM is different from the theory of planned behavior because it studies decision-making processes of users whether to adopt information technology or not. Despite the usefulness and practicability of TAM, the original model is limited when it comes to developing economies due to the inadequacy of technology on developing countries. Musaetal (2005) developed a more appropriate model for developing countries starting with perceived user source model (PUR) proposed by Mathieson, et al. (2001). The new model shown in Figure 3.1 incorporates the linkages between factors of socioeconomic development and technological infrastructure (as captured by accessibility to technology). The model also captures the individual's perception of both positive and negative impact factors. The positive impact factors are factors that propel sanction towards making fundamental improvements in its socio-economic development, while the negative impact factors constitute major impediments to socio-economic development. The perceived user resources are designated by "PR", which is the extent to which an individual believes that the personal and organizational resources needed to use an Information System are available. The perceived user resources include factors such as skills, human assistance, hardware, software, time, documentation, and money [Mathieson, etal. 2001].

The new model provides the dynamics between socioeconomic development as measured by human development indices and technology adoption that would further aid in national (human) development efforts. The "Accessibility and Exposure to Technologies" refers to the technology that is in place and available for use. These technologies include related ICTs such as internets, computers, telecommunications networks and any other form of technology in a user's world. The factors labeled "Perceived Positive-Impact Factors" and "Perceived Negative-Impact Factors" impact the"Individual's Perception of Socioeconomic Environment" (Musa, etal 2005). The extension of the perceived user resource model points out the importance of accessibility and exposure to technologies adoption and how the various factors in technology adoption and socioeconomic development interact with each other. Adequate technology adoption allows a country to realize the impact of technology. It is the impact of ICTs that is of most importance. According to Sein and Harindranath (2004) as cited in Musa et al (2005), research on ICT impacts posits three levels or effects:

i. First-Order or primary effects where simple old technology is substituted by old technologies. For example, access and ability to use a tractor alleviates the backbreaking hoe and hand-digger method of tilling the land. Another example is when telecommunication technologies provide faster alternatives to traditional means of communication (snail-mail). While realizing the primary effects does not generally imply development, it paves the way for higher order effects to take place. Such as health, democracy, good governance, economic productivity, social well-being, the physical environment, roads, water and power supply, education, employment, and pressure or desire to integrate into the world economy, etc.

Second-Order or secondary effects where a phenomenon such as technology-enabled correspondence take on a larger meaning, such as sharing of documents or graphics. For example, this effect aids in co-authoring of research across vast geographical areas.

ii. Third-Order or tertiary effects; the generation of technology-related businesses and societal change. For example, the introduction of communication technology should spur the development of new businesses, for example electronic communication-enabled media such as virtual organizations. We suggest that sustainable economic and human development would call for a systematic progression and maturation through these three effects. The proliferation of telecommunications in developed countries came as a result of the need for basic necessities of life are met, hence developing countries should learn a valuable lesson from that.

Barriers to Technology Acquisition in Developing Countries

The barriers and challenges encountered in acquisition of technology are:

i. Poor planning in developing countries which invariable affects the process of receiving the new technology.
ii. Limited understanding of the technology concept as it relates to the issues of installing and maintenance.
iii. Failure of recognition of local potentials for adopting new technology
iv. Failure to determine the possible applications of the transferred technology
v. Presence of ethical issues within the process of technology transfer
vi. Restricting the feasibility study of technology transfer to just financing assessment without evaluating the local potential adoption.

Strategies for Improving Technology Acquisition in Developing Countries.

A host economy can adopt the following strategies relating to technology transfer.

i. The host economy needs to be strong and vibrant so as to be able to absorb technology.
ii. There should be policies directed towards importing of technology, for instance, government can discourage restrictive clauses pertaining to technology transfer. The policy can influence the terms and conditions of technology transfer.
iii. Government should be able to encourage indigenous knowledge through domestic R&D.
iv. Countries can encourage and promote cross boarder collaborative R&D
v. Encourage indigenous production of technology by developing state owned enterprises.
vi. Encourage development of state-owned enterprises.
vii. Liberalized terms of technology transfer and diffusion that would benefit both parties.
viii. Encourage indigenous production of technology subsequent to transfer of technology.

CHAPTER THIRTEEN

MILITARY INDUSTRIAL COMPLEX

MIC was first used by the former USA President Eisenhower in his Farewell address in 1961; according to him nation's increasingly powerful military industrial complex is likely to become a military ruling nation. A driving factor behind the relationship between the military and the defense-minded corporations is that both sides benefit one side from obtaining war weapons, and the other from being paid to supply them. The term is most often used in reference to the system behind the military of the United States, where the relationship is most prevalent due to close links among defense contractors, the Pentagon, and politicians. The expression gained popularity after a warning of the relationship's detrimental effects, that nation's increasingly powerful military-industrial complex and the threat it posed to American democracy.

Military industrial complex is seen as informal alliance between a nation's military and the defense industry which supplies it. The goal is to gain political support for the increased of military spending by the national government. Military industrial complex are network of individuals and institutions involved in the production of weapons and military technology.

It is the distribution of the weaponry. Throughout history, states have usually fought one another in weapons symmetry, Connell (1989). It is therefore pertinent to note that those responsible for crafting the new and enhanced equipment in warfare are doing so at the expense of peace around the world, because the reality is that this modern weaponry will have to be sold in the open market to the highest bidder – either they are militias or governments. In Nigeria, the Defence Headquarters (DHQ) has expressed its determination to make Defence Industries Corporation of Nigeria (DICON) the epicenter of the proposed military industrial complex aimed at meeting the complete needs of the armed forces and making them self-sufficient in terms of local production.

The Chairman of the Committee on Establishment of Military Production, Air Vice Marshal Emmanuel Anebi, said on April 15th that a committee was formed to work out the modalities for a smooth take off of the military industrial complex, which "would be a conglomerate of various companies… while DICON will be at the centre to streamline or regulate all their activities."

On April 7th the Nigerian Army unveiled the first locally made explosives detonator, known as a Rechargeable Blasting Device, which is portable and adaptable to wet and cold conditions.

HISTORY OF MILITARY INDUSTRIAL COMPLEX

Some sources divided the history of the military industrial complex into three distinct eras;

First Era

from 1797 to 1941 the government only relied on civilian industries while the country was actually at war. The government owned their own shipyards and weapons manufacturing facilities which they relied on through World War I. With World War II came a massive shift in the way that the American government armed the military. With the onset of World War II President Franklin D. Roosevelt established the War Production Board to coordinate civilian industries and shift them into wartime production. Throughout World War II arms production in the United States went from around one percent of the annual GDP to 40 percent of the GDP. Various American companies, such as Boeing and General Motors, maintained and expanded their defense divisions. These companies have gone on to develop various technologies that have improved civilian life as well, such as night-vision goggles and GPS.

Second Era

The second era is identified as beginning with the coining of the term by President Dwight D. Eisenhower. This era continued through the Cold War period, up to the end of the Warsaw Pact and the collapse of the Soviet Union. In 1993 the Pentagon urged defense contractors to consolidate due to the collapse of communism and shrinking defense budget.

Third (Current) Era

In the third era, defense contractors either consolidated or shifted their focus to civilian. In the current era, the military industrial complex is seen as a core part of American policy-making. The American domestic economy is now tied directly to the success of the MIC which has led to concerns of repression as Cold War-era attitudes are still prevalent among the American public. Shifts in values and the collapse of communism have ushered in a new era for the military industrial complex. The Department of Defense works in coordination with traditional military industrial complex aligned companies such as Lockheed Martin and Northrop Grumman. Many former defense contractors have shifted operations to the civilian market and sold off their defense departments.

Today, the United States routinely outspends every other country for military and defense expenditures.
Military spending by some powerful countries 2021.

i. The United States ($778 billion)
ii. China ($252 billion [estimated])
iii. India ($72.9 billion)
iv. Russia ($61.7 billion)
v. United Kingdom ($59.2 billion)
vi. Saudi Arabia ($57.5 billion [estimated])
vii. Germany ($52.8 billion)
viii. France ($52.7 billion)
ix. Nigeria ($2.1million [estimated).

IMPACT OF TECHNOLOGICAL REVOLUTION ON MILITARY INDUSTRIAL COMPLEX:

It Improve the Standard of Warfare: Technology has overtime been instrumental to giving impetus and direction to warfare and this is seen in the evolution and transcendence of wars throughout history in different times and at different places. Standard of war, however have improve through the manufacturing of sophisticated weapons with miles sighting in order to detect the location and strategies of their opponent there is the certainty that these violent conflicts implore the use of instruments of war.

Technologies govern and dictate warfare; it is seen in most warfare scenarios to set the stage and act as a catalyst or instrumentality of warfare.

In all the most important euphemism describing the impact of technology on warfare is 'changes', this is rightly so as technology has been the primary source of military innovation throughout history. It has served as a driving factor in transcending wars more than any other variable. This point is even more glaring in the two aspects of warfare known to man which is the aerial and sea warfare. (i) Naval warfare does not occur without ships, which, through most of human history, were the most complex of human technological artifacts. (ii) Planes for air warfare, (iii) missiles for strategic warfare, (iv) spacecraft for Star Wars, (v) amour car for land warfare, (vi) development of satellite, in each case, the vehicle defines the warfare.

The U.S. boasts a missile defense installation that can stop the unstoppable, an intercontinental ballistic missile (it is used to deliver one or more warheads on a predetermined target. Warhead here refers to the front part of a bomb that carries the explosives object). Space-faring nations flirt with anti-satellite weapons launched from earth and even the prospect of space-based weapons to fight one another and threaten the earth below. Air warfare differs from naval warfare, not because the strategy and tactics of conflict in those realms differs, but because planes differ from ships. And, of course, both differ from tanks and rockets and satellites. Each technology shapes, defines, circumscribes, and governs a new kind of warfare.

Economic Impacts: The host countries of military industrial complex have the most stable large economies in the world. The industries make huge profit after productions and selling of military weapons to their users and this boost their economies due to high demands of weaponry and military technology. For any successful military industrial complex there must be varieties of mass production of military weapons (Sambo2021).

CONSEQUENCES OF TECHNOLOGY AND RESEARCH ON MIC

It promotes crime such as terrorism, kidnapping, criminology, banditry, militancy etc due to high rate of illegal possession of firearms by the citizens. It's endangered other sector of the economy because of inadequate allocation of fund. Military industrial complex is too expensive. The military may likely become powerful than the State which may result at a coup d'état. A single nuclear weapon and other explosive weapon can destroy a city and kill most of its people. Several nuclear explosions over modern cities would kill tens of millions of people. Casualties from a major nuclear war between the US and Russia would reach hundreds of millions. Example is the case of Hiroshima and Nagasaki bombings (mass killing). The manufacturing countries may instigate wars between two countries in order to sell their products. Military industrial complexes exacerbating tension around the world.

CHAPTER FOURTEEN

THE THIRD WORLD IN SCIENCE AND TECHNOLOGY

In general, nations are typically characterized by economic status and key economic metrics like gross domestic product (GDP), GDP growth, GDP per capita, employment growth, and an unemployment rate. In developing countries, low production rates and struggling labor market characteristics are usually paired with relatively low levels of education, poor infrastructure, poor sanitation, limit access to health care and low costs of living.

What Is the Third World?

"Third World" is an outdated and derogatory phrase that has been used historically to describe a class of economically developing nations. It is part of a four-part segmentation that was used to describe the world's economies by economic status. Third World falls behind First World and Second World but was ahead of Fourth World, though Fourth-World countries were hardly recognized at all. Today the preferred terminology is a developing nation, an underdeveloped country, or a low- and middle-income country (LMIC).

Developing Nations

There can be a few ways to divide up the world for purposes of economic segmentation. Classifying countries as First, Second, Third, and Fourth World was a concept created during and after the Cold War, which ran from approximately 1945 to the 1990s. Developing Nations are countries struggling on how to meet modernity. These countries are not developed but are trying to meet the standard of the world development.

Developing nations are closely watched by the International Monetary Fund (IMF) and the World Bank, which seek to provide global aid for the purposes of projects that help to improve infrastructure and economic systems comprehensively. Both organizations refer to these countries as lower-middle or low-income countries. Developing nations, or LMIC, can be the target of many investors seeking to identify potentially high returns through possible growth opportunities, though risks are also relatively higher. While developing countries are generally characterized as performing poorer economically, innovative and industrial breakthroughs can lead to substantial improvements in a short amount of time.

CONTEXTUAL FACTORS

According to oxford dictionary the word contextual means depending on or relating to the circumstances that form the setting for an event, statement, or idea. Contextual has the following synonyms; accompanying, associated, provisional, correlated, corresponding, etc. Therefore, we can say that contextual represent the external factors or surrounding factors that inhibit the implementation of science and technology. It includes the following;

The Complex Nature of Science and Technology: science covers a large sector of the world which makes implementation it hard for developing countries to arrivals the indices of science and technology. Science and technology are mainly known to developed countries than developing countries have a mess technological transfer which makes the process of certain policies a pain in the neck which is also one of the reasons why most policies in science and technology fail because of the complex and intricate nature of science and technology.

Deeply rooted Archaic Practice: The presence of semi-subsistence basis underlying these structures cannot assist in the conscious application of science and technology. On the contrary, it helps to preserve outdated, antediluvian implements work methods and ways of organizing social production. it makes it more difficult to generate social demand for the development of science and technology to create the necessary climate for technical innovations. Here also narrowed down the best deals for scientific and technological process essentially restricting it to a structure involving a majority of the population–national capitalism, the state sector coma foreign Monopoly capital and the state sector coma foreign Monopoly capital and mixed enterprises.

Conflict between Religion and science: Religion and science are fundamentally incompatible. They disagree profoundly on how we obtain knowledge of the world. Science is based observation and reasoning from observation. Religion assumes that human beings can access a deeper level of information that is not available by either observation or reason. It maintains that there is an intrinsic intellectual conflict between religion and science and that it inevitably leads to hostility. Most examples and interpretations of events in support of the thesis have been drawn from Western history. The history of Science is not a mere record of isolated discoveries; it is a narrative of the conflict of two contending powers, the expansive force of the human intellect on one side, and the compression arising from tradition, faith and human interests on the other.

Negative Influence Posed by Our Colonial Masters: The British came to Nigeria among other reason, for economic reason- as a ready market for their sprits, Dane guns, mirrors and other goods. Before the advent of colonialism Nigerians were involved in many aspects of industrial and practical arts. They made their own homes and other implements for farming, etc. According to Akaninwor, the colonialists discouraged further development of Nigerian technology as they reasoned it was a threat to the smooth marketing of goods imported from Europe. He went further to assert that "ogogoro" was termed illicit gin by the colonialists, and whoever was caught producing, marketing, or consuming it was frustrated .

Wrong Philosophy of Western Education: Western education is the main and proper channel for technological emancipation provided it is built on appropriate philosophy of education. The philosophy of Nigerian education during the colonial period was built on the wrong philosophy as can be confirmed by the statements of Lord Lugard and Rev. J. C. Taylor who said respectively: "The chief function of government primary and secondary schools among primitive communities is to train the more promising boys from the village schools as teachers for those schools, as clerks for the local native courts, and as interpreters: (Lord Lugard 1921)". "I looked upon them as the commencement of our missionary work. We lost no time and began to teach them the A. B. C." (Taylor 1857)". It is therefore not surprising that apart from the Yaba Higher College that was established in 1947 to produce middle level technical manpower, the colonialist only established secondary schools that were meant to produce clerks, missionaries, and interpreters. The aspect of education which emphasizes skill and practical competence was however not an integral part.

INSTITUTIONAL FACTOR

Traditionally the use of inappropriate technologies in the developing countries has been explained by the existence of factor price distortions, e.g. the price of labor being artificially raised by labor legislation, and the price of capital being reduced by subsidies and unrealistic exchange rates. In reality the technological choice is often determined by economic conditions and the local socio-cultural/political conditions. Institutional problems come from the generation and diffusion of technologies from the supply side which are introduced to people who do not see the need for them. More emphasis on the marketing side usually results in application of correct technology, especially where governments fund research and development projects and formulate their plans on the basis of a concrete investment or production plan and a clear idea about the target market. Land reforms and agricultural price policies are needed as well as the establishment of an efficient national administrative network. The institutional framework of the country may discourage the appropriate technology.

The obstacles can be overcome when the following conditions are met:

i. A national consensus about the need for development efforts and importance of policy goals;
ii. Promising market prospects and/or an effective marketing system; and,
iii. Sufficient industrial competition in both home and international markets.

The institutional factors represent the internal factors that hinder the implementation of science and technology policy. These factors could be seeing in the educational, economic, political, and social institution etc.

THE NIGERIAN CONDITION

Gradually, Nigerian authorities are recognizing that science and technology is the primary vehicle for development, but, to date, the recognition has not been matched by investment in resources, human or material. Funding for science and technology has never been a priority and has often resulted from external pressure rather than domestic conviction. Activities have been mostly in the public domain where they have been limited to establishment of institutions for research or to development of technical personnel, with emphasis usually being placed on formal technical training rather than on skill formation, practical experience, and innovation. Regrettably, policymakers continue to have a hazy conception of the role of science and technology and have thus failed to optimize its use for 5 national development planning. Nigeria, like the majority of African countries, has not yet mustered the political will and commitment. Without this commitment, countries cannot raise the effectiveness of the functioning of their economy, radically improve labor productivity, or optimize the use of their resources. The countries have come to depend mostly on foreign research & development, personnel, technology, even raw materials for their industries. In October 1979, a separate ministry of science and technology was created to take over the responsibilities of the National Science and Technology Development Agency, which, since its inception in 1977, had been groping unsuccessfully with development of a domestic capability. The ministry was given the mandate to promote and develop scientific and technologic research in the country. Its responsibilities were to include:

i. Formulation of national policy on science and technology
ii. Promotion of scientific and technologic research
iii. Liaison with universities and institutions of higher learning
iv. Promotion and administration of technology-transfer programs. Previously, programs for science and technology (S&T) had been established individually by the ministries and government departments responsible for their respective activities.

Nigeria has invested little in science, technology and innovation over the past three decades. The country's gross expenditure for research and development is at 0.2% GDP, less than half the world average of 0.4%. Many smaller African countries have done far better than Nigeria. Mozambique spends (0.5%), Mauritius (0.4%), Uganda (0.4%) and Botswana (0.5%) this lack of investment has handicapped research and development in strategic industries. The Nigerian agribusiness sector has remained stagnant for decades without generating the innovation that's necessary to transform the industry. Nigeria used to be a world leader in the palm oil industry. Today, it is nowhere near the level of production enjoyed by Indonesia and Malaysia - two countries which use technology better.

Despite being the largest producer of cassava in the world, Nigeria has lost its position as a market leader to Thailand. The cassava industry has weakened because it has not been supported by key government ministries parastatal in order to compete with their counterpart industries in other advance countries. In Nigeria, the links between different domains of policy, rather than being forged by imaginative action, do not exist; instead, there is a gap in the system through which issues simply disappear from sight. The links deserve particular attention because in countries such as Nigeria underdevelopment of technology is coupled with underutilization of the existing technological capacity. In fact, Nigeria -- because of its size, population, and potential could benefit more than most countries by developing links complemented by appropriate action.

Dike (2005) observes that in Nigeria the issue of the upsurge of corruption is troubling, and the damages it has done to the polity are astronomical. The menace of corruption leads to slow movement of files in offices, police extortion at tollgates and slow traffics on the highways, port congestion, queues at passport offices and gas stations, ghost workers syndrome, election irregularities, among others. Policy continuity in Nigeria is also a problem, according to Akuta (2009) once a new government takes over power, they usually abandoned previous governmental policies or programs. Only few policies were retained by subsequent administrations both in military and civil rules. For example. The national youth service corps (NYSC) has lasted over 35years. Policy inconsistencies are an avenue for siphoning public funds, each government policy, program or project cancelled affects government revenue, and it brings destabilization which sets citizens and the nation backwards especially when the people have invested money, time, and other resources.

Nigeria has been exceptionally blessed and favored with abundant natural, minerals and human resources. A nation that is totally devoid of natural calamities or disasters cannot be said to be less favored. In Nigeria the only disaster is bad leadership. The failure of Nigerian leaders to raise the standard of living of an average Nigerians beyond poverty line coupled with unemployment and this has dampened the morale of most Nigerians with respect to the possibility of finding an effective solution to the various challenges confronting Nigeria as a nation. Ogbu (2004) says that Africans brain drain phenomenon has both pull and push factors that have contributed significantly to the poor state of science and technology in the region. Given poor political and economical conditions of most African states, many top scientists left the shores of Nigeria and refused to return because some developed countries also put in place policies that will attract highly specialized Africans by depleting the stock margins.

In Nigeria, the objectives in the national policy on education of 1981 was to train manpower in engineering, applied science, technology and commerce at all professional grades, provision of technical knowledge and vocational skills necessary for agricultural, industrial, commercial and economic development etc. objectives have becomes merely theories. A review of Nigerian polytechnic systems reveals that polytechnic education is underrated, discriminated, disowned, neglected, denigrated, snubbed and ignored and these rendered the sector useless and unrealistic. The standard of education is falling and the consequences are the production of half-backed graduates and job seekers who incidentally roam the streets.

Ibiyemi (2007) stressed that Nigerian educational system need to be restructured. The restructuring is to address the issues of falling standard, lopsidedness in the in-admission processes. University education may not be for everyone, but everyone should give equal opportunity or chance to prove their ability and intellectual potentials. Maduagwu (2000) says Nigeria is politically unstable besiege with northern forces campaign for Sharia law enactment and seems to have all the governor agreement, the South-East where MASSOB holds sway, to the South-West and South-South militants have been championing a violent form of ethnic nationalism, right down to the creeks of the Niger Delta where the youths are in a virtual state of rebellion. Inflow of foreign investments cannot take place in an environment of political and economic instability.

According to Iredale (2003), countries with the most intellectual resources achieve the highest rates of economic growth and the fastest development in science and technology. But knowledge produces more than economic riches; it is also a vital ingredient for dealing with many of the social and environmental problems of life today. In the drive for human capital development, many industrialized countries like, United States, United Kingdom, Canada, Germany, Japan, Singapore, Hong Kong and Australia are giving priority to policies aim and options.

CHAPTER FIFTEEN

CYBERSECURITY AND DATA PROTECTION

Cybersecurity, rooted in the essential value of data and information within cyberspace, derives its name from "cyber," which pertains to computer systems, networks, and the internet. It means securing and safeguarding sensitive information and data in computer systems and networks from entities who may steal or destroy them (Taherdoost, 2022). Since the advent of the internet and the rapid proliferation of technological devices and systems, cybersecurity has gained widespread significance.

Data and information is a valuable commodity in today's technologically advanced society. Businesses, individuals and governments amass and work with large amounts of information. This makes the capture and storage of data and information extremely important and cybersecurity vital in securing this data because in the wrong hands, they can become weapons for good or bad. Cybersecurity threats do not just affect individuals but can have lasting effects on businesses, corporations, national security and economies.

Types Of Cybersecurity Threats

Cybersecurity threats and attacks come in various types; they include:

i. **Denial-of-Service (DoS) and Distributed Denial-of-Service (DDoS) Attacks:** Like the name implies, this form of attack is intended to keep users of a particular service barred from accessing the service. They can have business and economic implications to those who are targeted.

ii. **Man-in-the-Middle (MitM) Attacks**: In this type of cyber-attack, a hacker intercepts the communication between two entities without their knowledge with the aim of stealing or distorting the information shared.

iii. **Phishing:** Phishing attacks are executed using social engineering tactics like sending emails from seemingly trustworthy sources to steal sensitive information like login details, details of bank cards, etc.

iv. **Drive-by Attacks**: This type of cyber-attacks happen when a person who intends to visit a website but is redirected to another website, which injects a malicious virus into their computer device without their knowledge.

v. **Password Attacks**: This form of cyber-attack is aimed at gaining access to a person's password using various techniques like guessing, and software-enabled listening.

vi. **Credential Stuffing Attacks**: This is a form of password attack whereby cyber criminals use passwords and login credentials obtained from data breaches.

vii. **SQL Injection Attacks**: Here, attackers find security gaps in the code of a website and malicious code/commands for their malicious intent.

viii. **Cross-Site Scripting (XSS) Attacks**: This form of cyber-attack involves modifying the code and process of a website to extract data and information from an unsuspecting victim.

ix. **Ransomware**: Ransomware is considered as one of the biggest cyberthreats today. It holds a victim's information, data and system hostage, requesting a fee for its release. The information that is held hostage is usually very valuable to the victim.

x. **Malware Attacks**: Malware is short form malicious software and is a software or computer program that infiltrates and proliferates a computer system. They are used for various purposes, including lagging a computer system, corrupt files, providing access to a cyber-criminal, theft and manipulation.

The increasing frequency and magnitude of cyber-attacks have escalated cybersecurity into a critical and rapidly evolving policy issue, particularly in the context of technological advancements. As cyber threats become more sophisticated and pervasive, both enterprises and governments are compelled to develop and implement robust policies that safeguard data protection and privacy. This urgency is driven by the need to protect sensitive information, maintain public trust, and ensure the resilience of digital infrastructures against potential breaches. Consequently, comprehensive cybersecurity strategies are now integral to national security agendas and corporate governance frameworks, highlighting the essential role of policy in navigating the complexities of the digital age.

DATA PROTECTION AND PRIVACY CONCERNS

What is data?

Data are facts that can be used to make informed decisions (Olson, 2021). Our modern society is built on the bedrock of Data as it plays a significant role in policy, business and even health decisions. According to Jalan and Winterhalter (2021) data includes measurable and descriptive variables about a person or object, produced by the person or object, which can be extracted, refined into information and transformed into knowledge for use.

Data protection

Since data is a valuable commodity in today's world, a key concern regarding data today is who produces it, who owns data, who has access to data and how it will be used i.e. the issue of data protection and privacy (Li & Saxunová, 2020). In discussing data protection, it is imperative that types of data as it concerns data protection and privacy must be discussed.

Personal Data

Personal data, also known as personally identifiable information (PII), refers to any information that can be used to identify an individual. This type of data is broad and encompasses various forms of information that relate to an identifiable person. They include: name, address, age, gender, nationality, IP address, login details, etc.

Personal data is the cornerstone of many digital interactions and services. Its protection is vital to prevent identity theft, fraud, and other malicious activities. Organisations and governments have set policies like the General Data Protection Regulation (GDPR) by the European Government, the California Consumer Privacy Act (CCPA), ECOWAS Data Protection Act, etc in place to regulate the collection, processing, and storage of personal data to ensure an individual's privacy is protected.

Sensitive Data

Sensitive data is a special and higher-level data that requires more protection because it has the potential to cause deeper risk to an individual in the wrong hands. Examples of sensitive data include medical and genetic records, Identity numbers, bank accounts numbers and card details, financial transaction information, political opinions, criminal records, biometric data like fingerprints, etc.

If sensitive data is not handled properly, it can cause disastrous consequences like identity theft, discrimination, and significant financial harm. As a result, the protection of sensitive data is paramount in both legal and ethical terms. Laws and regulations often impose additional requirements for processing sensitive data, such as obtaining explicit consent from individuals and implementing enhanced security measures.

Privacy Concerns in the Digital Age

In today's ICT age, privacy concerns have become a focal point of public discourse, largely because of the high-profile incidents that have highlighted the vulnerabilities and misuse of personal data. One of the most notable examples is the Facebook–Cambridge Analytica data scandal, where data from millions of Facebook users was harvested via a seemingly harmless quiz. This data was then sold, studied, and ultimately used to influence the outcome of the 2016 presidential elections in the United States. This scandal is often cited as a prime example of data misuse and privacy violations, shedding light on the broader implications of digital privacy.

Digital Privacy

Digital privacy refers to the ability and right of an individual to control and protect the way their personal and sensitive digital data and information is collected, stored, and processed (Bélanger & Crossler, 2011). In the current technological landscape, vast amounts of data are generated and shared across multiple platforms, raising concerns about how this data is handled and who has access to it. Key aspects of digital privacy include:

i. **Data Collection:** The methods and extent to which personal data is collected by companies, governments, and other entities.
ii. **Data Usage:** How the collected data is used, whether for advertising, research, or other purposes.
iii. **Data Sharing:** The sharing and selling of personal data to third parties, often without explicit consent from users.
iv. **Data Security:** Measures taken to protect data from unauthorized access, breaches, and theft.

Breach of digital privacy can have far-reaching consequences for individuals and society at large. The Facebook–Cambridge Analytica scandal is a case in point, demonstrating how personal data can be exploited for political manipulation and other nefarious purposes. Privacy breaches can bring harm to individuals, breed loss of trust in institutions, personal losses, damage to reputation, governments and digital/tech platforms, undermine political processes and economic implications. This has prompted governments and regulatory bodies to introduce policies regarding data protection and privacy.

Ethical Implications of Data Security

The ethical implications of data security are steeped in the fundamental rights of every human and the values of the society. Data security is not just a matter of protecting information but also involves upholding ethical standards that respect privacy, autonomy, and dignity.

i. **Privacy:** Privacy is a fundamental human right, and data security plays a crucial role in safeguarding this right. Ethical data security practices ensure that individuals' personal information is protected from unauthorised access and misuse. Issues like informing and obtaining consent from an individual on how their data will be collected, used and shared (informed consent) and confidentiality are sacrosanct to maintaining privacy.
ii. **Autonomy:** Every person has the right to control and manage their personal data. This means that organisations or anybody that deals with data from individuals must be transparent about their data practices, allow the individual whom the data is obtained from to access, edit and transfer their data.

iii. **Appropriate Use and Minimization of Data:** All data collected must be used for the purposes it was originally intended for. If the purpose changes, the individual whom the data was obtained from must be duly informed and consent received. Minimization has to do with the collection and retention of only necessary data.

iv. **Profiling and Discrimination:** This has to do with creating profiles, categorising and making predictions of individuals. Ethically, profiled data should not be used to strengthen biases.

v. **Retention, Sharing and Safety:** Data should be kept for only an appropriate duration for its use, encrypted to prevent unauthorised access, and transparent data sharing practices put in place to ensure that data is safe.

CHAPTER SIXTEEN

INTELLECTUAL PROPERTY AND TECHNOLOGY OWNERSHIP

According to WIPO Academy (2024), Intellectual property (IP) refers to creations of the mind, such as inventions; literary and artistic works; designs; and symbols, names, and images used in commerce. Will, Khadija, and Jared (2024) explained that Intellectual property is a broad categorical description of a set of intangible assets owned by a company or individual. It's legally protected from outside use or implementation without consent. An intangible asset is a non-physical asset they added that "the concept of intellectual property relates to the fact that certain products of human intellect should be afforded the same protective rights that apply to physical property, called tangible assets (Will, Khadija & Jared, 2024).

Importance of Intellectual Property

Intellectual property can be used for various reasons such as,

i. Branding
ii. Marketing
iii. Protecting assets
iv. Enhancing competitive advantage in property or business.

The concept of Technology Ownership

Intellectual property is a form of technology ownership. Owned technology means all Technology that is owned, purported to be owned (in each case whether owned singularly or jointly with a third party or parties), or filed by, assigned to, or held in the name of, or exclusively licensed to, the Company or any of its Subsidiaries.

Having the right type of intellectual property protection helps you to stop people from stealing or copying:

i. the names of your products or brands
ii. your inventions

iii. the design or look of your products
iv. things you write, make, or produce

Ladas (1975) explained that the creator of a work is generally deemed to be its owner. Still, intellectual property ownership can be determined differently for various types of property and under different circumstances. The employer owns that intellectual property if the work was created for them. Ownership rights can also be transferred to other parties.

What counts as Intellectual Property

WTO (2024) explained that Intellectual property is something that you create using your mind - for example, a story, an invention, an artistic work, or a symbol.

You own intellectual property if you:

i. created it (and it meets the requirements for copyright, a patent or a design)
ii. bought intellectual property rights from the creator or a previous owner
iii. have a brand that could be a trademark, for example, a well-known product name

Intellectual property can:

i. have more than one owner
ii. belong to people or businesses
iii. be sold or transferred

Intellectual property if you're self-employed

If you're self-employed, you usually own the intellectual property even if your work was commissioned by someone else - unless your contract with them gives them the rights. You usually will not own the intellectual property for something you created as part of your work while you were employed by someone else

Will, Khadija, and Jared (2024) revealed that IP is protected in law by, for example, patents, copyrights and trademark which enable people to earn recognition or financial benefit from what they invent or create. By striking the right balance between the interests of innovators and the wider public interest, the IP system aims to foster an environment in which creativity and innovation can flourish. According to the World Trade Organization (WTO) (2024), Intellectual property rights (IPR) are the rights given to persons over the creations of their minds. They usually give the creator an exclusive right over the use of his/her creation for a certain period. Intellectual property rights are customarily divided into two main areas:

Copyright and rights related to copyright: The rights of authors of literary and artistic works (such as books and other writings, musical compositions, paintings, sculpture, computer programs, and films) are protected by copyright, for a minimum period of 50 years after the death of the author. Also protected through copyright and related (sometimes referred to as "neighboring") rights are the rights of performers (e.g. actors, singers, and musicians), producers of phonograms (sound recordings), and broadcasting organizations. The main social purpose of the protection of copyright and related rights is to encourage and reward creative work (WTO, 2024).

Industrial property: Industrial property can usefully be divided into two main areas. One area can be characterized as the protection of distinctive signs, in particular trademarks (which distinguish the goods or services of one undertaking from those of other undertakings) and geographical indications (which identify a good as originating in a place where a given characteristic of the good is essentially attributable to its geographical origin).

i. The protection of such distinctive signs aims to stimulate and ensure fair competition and to protect consumers, by enabling them to make informed choices between various goods and services. The protection may last indefinitely, provided the sign in question continues to be distinctive. Other types of industrial property are protected primarily to stimulate innovation, design, and the creation of technology. In this category fall inventions (protected by patents), industrial designs, and trade secrets.

ii. The social purpose is to protect the results of investment in the development of new technology, thus giving the incentive and means to finance research and development activities. A functioning intellectual property regime should also facilitate the transfer of technology in the form of foreign direct investment, joint ventures, and licensing. The protection is usually given for a finite term (typically 20 years in the case of patents) (WTO, 2024).

Types of Intellectual Property

According to Will, Khadija, and Jared (2024), there are four main types of intellectual property. They list them to include patents, trademarks, copyrights, and trade secrets.

Patents: A patent is an exclusive right granted for an invention. A patent provides the patent owner with the right to decide how - or whether - the invention can be used by others. In exchange for this right, the patent owner makes technical information about the invention publicly available in the published patent document

Trademark: A trademark is a sign capable of distinguishing the goods or services of one enterprise from those of other enterprises. Trademarks date back to ancient times when artisans used to put their signature or "mark" on their products.

Copyright: Copyright is a legal term used to describe the rights that creators have over their literary and artistic works. Works covered by copyright range from books, music, paintings, sculptures, and films to computer programs, databases, advertisements, maps, and technical drawings.

Trade Secrets: Trade secrets are IP rights on confidential information which may be sold or licensed. The unauthorized acquisition, use, or disclosure of such secret information in a manner contrary to honest commercial practices by others is regarded as an unfair practice and a violation of the trade secret protection

In addition to the above-listed types, WIPO Academy (2024) mentioned the following,

Industrial designs: An industrial design constitutes the ornamental or aesthetic aspect of an article. A design may consist of three-dimensional features, such as the shape or surface of an article, or two-dimensional features, such as patterns, lines, or color.

Geographical indications: Geographical indications and appellations of origin are signs used on goods that have a specific geographical origin and possess qualities, a reputation, or characteristics that are essentially attributable to that place of origin. Most commonly, a geographical indication includes the name of the place of origin of the goods.

Franchises: A franchise is a license purchased by a company, individual, or a party called the franchisee. It allows them to use the franchisor's name, trademark, proprietary knowledge, and processes. The franchises is typically a small business owner or an entrepreneur who operates the store or franchise. The license allows the franchisee to sell a product or provide a service under the company's name. The franchisor is paid a start-up fee in return as well as ongoing licensing fees by the franchisee. Examples of companies that use the franchise business model include United Parcel Service (UPS) and McDonald's(MCD) (Will, Khadija & Jared, 2024).

Intellectual Property Infringement

Will, Khadija & Jared (2024) pointed out that there are certain rights known as intellectual property rights attached to intellectual property. They can't be infringed upon by those without authorization to use them. Intellectual property rights allow owners to bar others from recreating, mimicking, and exploiting their work (Moberly, 2014). Penalties for intellectual property infringement range from fines to prison sentences. The various forms of infringement that occurs include,

i. Patent infringement occurs when a legally protected patent is used by another person or company without permission. Patents filed before June 8, 1995, were valid for 17 years. Patents filed after this date are valid for 20 years. The details of the patent are made public after the expiration date.

ii. Copyright violations occur when an unauthorized party recreates all or a portion of an original work such as art, music, or a novel. The duplicated content need not be a replica of the original to qualify as an infringement.

iii. Trademark infringement occurs when an unauthorized party uses a licensed trademark or a mark resembling the licensed trademark. A competitor might use a mark like its rivals to disrupt business and attract their customer base. Businesses in unrelated industries may use identical or similar marks to capitalize on another company's strong brand image (*Ladas, 1975)*.

iv. Trade secrets are often protected by NDAs. They've violated the agreement and infringed upon the trade secret if a party to the agreement discloses all or parts of a trade secret to uninterested parties. It's possible to be guilty of trade secret infringement when an NDA isn't present.

Avoiding Intellectual Property Infringement

According to Teich and Roy (1996), infringement is often done unwittingly. They advised that you must make sure that your business isn't using copyrighted or trademarked material to avoid being sued for infringement on intellectual property. Be sure that your brand or logo isn't too like that of others so it could reasonably mislead someone into thinking it was the other brand. In addition, they stress that you must "make sure the contract explicitly states that any creative work that's generated becomes the property of the company and not the person you hired if you hire someone to do creative work for you or your company".

Issues of Biopiracy

According to Gulati (2019), biopiracy is the unauthorized acquisition of genetic resources or traditional knowledge through patents that limit its future utilization. Biopiracy often involves exploiting the biological resources and indigenous knowledge of local communities without proper compensation or acknowledgment. There are a number of cases of developed nations appropriating traditional knowledge of developing nations in the invention of new products, like the Turmeric patent war in India (Kumar, 1997). This practice raises significant ethical, environmental, and economic concerns. Developing nations, rich in biodiversity and traditional knowledge, frequently find their heritage appropriated by foreign entities that profit from these resources without sharing the benefits.

Ethically, biopiracy undermines the rights of indigenous communities. It disregards their contributions to global knowledge and deprives them of potential economic benefits.

Case Studies of Biopiracy

One of the most cited examples of biopiracy is the case of Turmeric. In 1995, two American researchers were granted a U.S. patent for the use of turmeric in wound healing. However, turmeric had been used in India for centuries for its medicinal properties. The Indian Council for Scientific and Industrial Research (CSIR) challenged the patent, arguing that the use of turmeric for healing was not a novel invention but traditional knowledge. In 1997, the U.S. Patent and Trademark Office revoked the patent, acknowledging that the use of turmeric was indeed prior art (Kumar, 1997).

Another prominent example is the Neem tree. The Neem tree, native to India, has been used for centuries in traditional medicine, agriculture, and other applications. In the 1990s, an European company obtained a patent for an extraction technique of Neem oil, which was used as a pesticide. Indian organizations contested the patent, and in 2000, the European Patent Office ruled in favor of India, revoking the patent on the grounds that the technique was based on traditional knowledge (Imran, Wijekoon, Gonawala, Chiang, & De Silva, 2021).

CHAPTER SEVENTEEN

FUTURE OF SCIENCE AND TECHNOLOGY POLICY

Policies related to science and technology are designed to foster innovation and promote economic benefits for a country or region. According to D. Stine (2009), these policies are crucial for the allocation of resources to support scientific research and development. They also guide the application of scientific knowledge and innovations, as well as the education of scientific and technological disciplines.

Research and innovations in science and technology are closely connected to societal needs and the national economy in sectors like transportation, communication, agriculture, education, the environment, health, defense, and employment. Consequently, policymakers have a vested interest in nearly every facet of science and technology policy.

The interplay between science, technology, and policymaking can be seen in two ways: "policies that influence science and technology," such as whether the government should fund research in renewable energy, and "science and technology informing policy," such as deciding if the government should implement regulations based on advancements in agricultural biotechnology (D. Stine, 2009). Following this, there are four elements that make of science and technology policy:

Science for policy
Technology for policy
Policy for science
Policy for technology
Emerging Trends in S&T Policy
Regulating Emerging Technologies

REFERENCES

Adamolekun, L (1983). Public Administration in Nigeria and Comparative Perspective, New York: Longman Inc.

Ahmed, A. (2002). 'Ibn Khaldun's understanding of civilizations and the dilemmas of Islam and the West today', Middle East Journal, Vol. 56, No. 1, pp. 20-45.

Akubue, A. (2000). Appropriate technology for socioeconomic development in Third world countries. The Journal of Technology Studies, 26(1), 33-43 https://www.jstor.org/stable/43604562

Akubue, A. (2000). Appropriate technology for socioeconomic development in Third world countries. The Journal of Technology Studies, 26(1), 33-43 https://www.jstor.org/stable/4360

Alex Roland, (2007). “Was the Nuclear Arms Race Deterministic?” paper prepared for the 50th Anniversary Workshop of the Society for the History of Technology, Washington, DC, 18 Oct. 2007.

Alfred, N, Science and the Modern World (New York: Free Press, [1925] 1953), 96

Archibugi, D. &Pietrobelli, C. (2003). The globalisation of technology and its implications for developing countries. Technological Forecasting And Social Change.

Arthur, W. B. (2009). The Nature of Technology. New York: Free Press. p.28.

Bayart, J. F. (2009). The state in Africa: the politics of belly. London: longman.

Beaney, M. (2014). Analysis (Stanford Encyclopedia of Philosophy). Available online: http://plato.stanford.edu/entries/analysis/

Bélanger, N., & Crossler, N. (2011). Privacy in the Digital Age: A review of Information Privacy Research in Information Systems. Management Information Systems Quarterly, 35(4), 1017. https://doi.org/10.2307/41409971

Bhargava, P. M. (2006). The social, moral, ethical, legal and political implications of today's biological technologies: An Indian point of view. Biotechnology Journal, 1(1), 34–46. https://doi.org/10.1002/biot.200500007

Blueford, J. R., & Rosenbloom, O. A. (2003). Making Science and Technology.

Boylan, M., & Johnson, C. (2010). Philosophy: An innovative introduction: Fictive narrative, primary texts and responsive writing. Boulder: WestviewPress.

Ceruzzi, Paul (2012). Computing: A Concise History. Cambridge, MA: MIT Press. p. 105. ISBN 9780262517676.

Collings, D. G., & Wood, G. (2009). Human resource management: A critical approach. In D. G. Colligs & G. Wood (Eds.), Human resource management: A critical approach (pp. 1-16). London: Routledge.

D. Stine, D. (2009, May). Science and Technology Policymaking: A Primer.

Davis, F. D., Bagozzi, R. P., and Warshaw, P. R., (1989). User acceptance of computer technology: A Comparison of Two Theoretical Models. Management Science (35),982-1003.

DeWitt, Calvin. "Christians and the Environment: How Should Christians Think about the Environment? - Christian Research Institute. "Christian Research Institute. N.p., n.d. Web. 04 Oct. 2016.

Dickson, D. (1994). Alternative technology and the politics of technical change. USA: Fontana Press.

Drëiìakhlov, N.I. (1984). The Scientific and Technological Revolution: Its Role in Today's World. Moscow: Progress Publishers.

Education accessible to children of all horizons. Connect: UNESCO International Science, Technology & Environmental Education Newsletter.

Ehrlich, Paul R. "Human Natures: Genes Cultures, and the Human Prospect" Island Press, 2000, pp. 203-252.

Eneh, O. C. (2010). Technology transfer, adoption and integration. A review of Applied Science, 10(16),1814-1819.

Ezeani, E.O (2006).Fundamentals of Public Administration, Enugu: Zik-Chuks Publishers

Fara, P. (2009). Science: A Four Thousand Year History. Oxford: Oxford University Press.

Fashola, M. A. (2001). Macroeconomic theory highlights and policy extensions for less- developed economies. (3rd ed.). Lagos: Concepts Publishers Ltd.

For further reading and more detailed information about the course, the following materials are recommended:

ForumCosmos. (2023, July 13). Ethical considerations in data privacy and security. Medium. Retrieved from https://medium.com

Gallivan, M. J., (2001). Organizational adoption and assimilation of complex technological innovations: Development and application of a new framework. Database for Advances in Information Systems, (35)3,51-85.

Grubler, A. (n.d). Technology and global change. International Institute for Applied Systems Analysis Laxenburg,Austria

Gulati, R. (2019). BIOPIRACY, a BIOLOGICAL THEFT? International Journal of Legal Studies, 5(1), 349–388. https://doi.org/10.5604/01.3001.0013.3244

Haque, E., Shanaj, M., Akhter, F., & Shafin, S. (2022). A Commentary on the Importance of Ethics in Scientific Research. E Scientific, 4(1). https://escientificpublishers.com/importance-of-ethics-in-scientific-research-JAA-04-0037

Heeks, R. & Stanforth, C. (2015). Technological change in developing countries: Opening the black box of process using actor-network theory. Development Studies Research, 2(1),33-50.

Hicks, N. & Streeten, P. (1979). Indicators of development: The search for a basicneed yardstick. World Development, 7(6),568-580.

Hippocrates — The Father of Medicine'. Kos Hellas Travel Guide. https://www.kosisland.gr/en/kosisland-history/hippocrates-from-kos.html

Howitt, P. (2007). Innovation, Competition and Growth: A Schumpeterian Perspective on Canada's Economy. C. D. Howe Institute Commentary https://web.archive.org/web/ 20110717090449

Imran, Y., Wijekoon, N., Gonawala, L., Chiang, Y., & De Silva, K. R. D. (2021). Biopiracy: Abolish corporate hijacking of indigenous medicinal entities. the Scientific World Journal/The Scientific World journal, 2021, 1–8. https://doi.org/10.1155/2021/8898842

Iyengar, Nandita. 'Inspirational Quotes: Who was the first to say "knowledge is power"?'. Quora. https://www.quora.com/Inspirational-Quotes-Who-was-the-first-to-say-knowledge-is-power

Jalan, Nupur & Winterhalter, Jan. (2021). What is Data? An interdisciplinary approach to define data RESEARCH COLLABORATION ON CONFLUXDATA.NET WORKING PAPER SERIES 1 PART 2.

Jhingan, M. L. (2007). The economics of development and planning. (39th ed.). Delhi: Vrinda Publications (P)Ltd.

Johnason, P. (2009). HRM in changing organizational contexts. In D. G.Collings & G. Wood (Eds.), Human resource management: A critical approach (pp. 19-37). London: Routledge.

Jose-de, C. (1974). Technology transfer and the developing nations, New York: Council of the Americas press. Journal of Development Studies, 44(3),613-621

Kahney, Leander (2003). "Grandiose Price for a Modest PC". Wired. Retrieved 2019-11-04.

Kanakia, H., Shenoy, G., & Shah, J. (2019). Cambridge Analytica a case study. Indian Journal of Science and Technology, 12(29), 1–5. https://doi.org/10.17485/ijst/2019/v12i29/146977

Klerck, G. (2009). "Industrial relations and human resource management". In D. G. Collings & G. Wood (Eds.), Human resource management: A critical approach (pp. 238-259). London:

Krige, J. and Dominique, P. eds., (2003) Science in the Twentieth Century, London: Routledge.

Kroeker, By Kirk L. "Interview with the Episcopal Church's Tom Ferguson." Technology and Religion. N.p., n.d. Web. 04 Oct. 2016.

Kuhn, Thomas S. (2012). The Structure of Scientific Revolutions. 50th anniversary. Ian Hacking (intro.) (4th ed.). University of Chicago Press. p. 264.

Kumar, S. (1997). India wins battle with USA over turmeric patent. Lancet, 350(9079), 724. https://doi.org/10.1016/s0140-6736(05)63536-2

Kuznets, S. (1973). Modern economic growth: Findings and reflections. TheAmerican Economic Review,63(3).

Ladas, S. P. (1975). Patents, trademarks, and related rights: national and international protection. Cambridge, Mass: Harvard University Press. ISBN 978-0-674-65775-5.

Lamb, Frank. Industrial Automation: Hands On (English Edition). NC, McGraw-Hill Education, 2013. ISBN 978-0071816458

Lee, W., Zankl, W., & Chang, H. (2016). An Ethical Approach to Data Privacy Protection. ISACA, 6. Retrieved from https://www. isaca.org/resources /isaca-journal/issues /2016/volume- 6 /an-ethical-approach-to-data-privacy-protection

Li, Y., & Saxunová, D. (2020). A perspective on categorizing Personal and Sensitive Data and the analysis of practical protection regulations. Procedia Computer Science, 170, 1110–1115. https://doi.org/10.1016/j.procs.2020.03.060

Lyshevski, S.E. Electromechanical Systems and Devices 1st Edition. CRC Press, 2008. ISBN 1420069721.

M. C. Uzonwanne & C. U. Kalu (Eds). Principles of economics II. (164 - 178). Nigeria: Djompol Printers &Publishers.

MacKinnon, P. C., & MacKinnon, G. (2013). Technology Integration in Developing Countries: A Case Study of Higher Education in Jamaica. International Journal of Technology, Knowledge & Society.

Manhattan Project'. History. https://www.history.com/topics/world-war-ii/the-manhattan-project

Marinko, G. I. (1989). What is the Scientific and Technological Revolution? Moscow: Progress Publishers.

Mathieson, K., Peacock, E., & Chin, W., (2001). Extending the technology acceptance model: The influence of perceived user resources. Database for Advances in Information Systems, (32)3, 86 –112.

Metu, A. G. (2017). Economic growth and development. In U. R. Ezenekwe, K. O.Obi,

Moberly, M. l. D. (2014). Safeguarding Intangible Assets. Butterworth-Heinemann. pp. 33–35. ISBN 978-0-12-800516-3.

Musa, P. F., Meso, P., & Mbarika, V. W. (2005). Toward sustainable adoption of technologies for human development in sub-Saharan Africa: Precursors, diagnostics, and prescriptions. Communication for the Association of the Information System,15(33).

Musa, P. F., Meso, P., & Mbarika, V. W. (2005). Toward sustainable adoption of technologies for human development in sub-Saharan Africa: Precursors, diagnostics, and prescriptions. Communication for the Association of the Information System,15(33).

Obedgiu, Vincent (2017-01-01). "Human resource management, historical perspectives, evolution and professional development". Journal of Management Development. 36 (8): 986–990. doi:10.1108/JMD-12-2016-0267. ISSN 0262-1711.

Okoro, J (2005). Public Policy Analysis A Theoretical Overview Calabar; OjiesOjies Productions.

Olajide, O. T. (2004). Theories of economic development and planning. Lagos: Pumark Nigeria Ltd.

Olson, K. (2021). What are data? Qualitative Health Research, 31(9), 1567–1569. https://doi.org/10.1177/10497323211015960

Paauwe, J., & Boon, C. (2009). Strategic HRM: A critical review. In D. G. Collings, G. Wood (Eds.) & M.A. Reid, Human resource management: A critical approach (pp. 38-54). London: Routledge.

Ray, A. K. and Bhurchand, K.M. (1975). Advanced Microprocessors and Peripherals. India: Tata McGraw-Hill. "Upward Compatible Software and Downward Compatible Price". Computerworld. p. 49.

Resnik, D., & Shrader-Frechette, K. (1996). Ethics of scientific research. Noûs/NoûS, 30(1), 133. https://doi.org/10.2307/2216307

Rifkin, Jeremy (1995). The End of Work: The Decline of the Global Labor Force and the Dawn of the Post-Market Era. Putnam Publishing Group. pp.66 75. ISBN. 978-0-87477-779-6.

Romer, P. (2007). From the Concise Encyclopedia of Economics. D. R. Henderson, (Ed.), Liberty Fund. www.ecolib.org/library/Enc/EconomicGrowth.

Ross, Cody. “China and Gunpowder.” Middle Ages Technologies. Four Rivers Charter, n.d. Web. 04 Oct. 2016.

Routledge.1928-, Armstrong, Michael (2009). Armstrong's handbook of human resource management practice. Armstrong, Michael, 1928- (Eleventh ed.). London: Kogan Page. ISBN 9780749457389. OCLC 435643771.

Shun, L. C. (2017). A comprehensive definition of technology from an Ethological perspective. Social Sciences (ISSN2076-0760).

Simurina, J & Tica, J. (2006). Historical perspectives of the role of technology in economic development. Working Paper Series No6-10.

Soliman, R. a. M. M. (2021). Ethics of scientific research. International Journal of Academic Research in Business & Social Sciences, 11(12). https://doi.org/10.6007/ijarbss/v11-i12/11922

Suad, M. (2000). Development through technology transfer. Bristol: Intellect Books/ Szirmal, A. (n.d). The dynamics of socioeconomic development

Sulc, O. (1977). Methodology of Forecasting Complex Development Processes of the Scientific and Technological Revolution. New Delhi: Centre for the Study of Science, Technology, and Development, Council of Scientific and Industrial Research.

Tarek Khalil & Ravi Shankar (2016). Management of technology (2nd ed.). India: McGraw Hill Education. pp 372-380.

Teich, M. P., and Roy, eds. (1996). The industrial revolution in a national context: Europe and the USA (1. publ ed.). Cambridge: Cambridge Univ. Press. ISBN 978-0-521-40940-7.

Todaro, M. P. & Smith, S. C. (2012). Economic development, 11th ed. Boston: United States of America: Pearson Publishers.

Torrance, Jack (25 July 2017). "Robots for Trump: Did automation swing the US election?". Management Today.

Whitbeck, R. H. “The Influence of Geographical Environment upon Religious Beliefs.” (n.d.): n. pag. Geographical Review. American Geographical Society, 10 Apr. 2016. Web.

Williman, A.O. and Jelinek, H.J. (1976). "Special Tutorial: Introduction to LSI Microprocessor Developments". Computer. IEEE. 9 (Computer): 37. doi:10.1109/C-M.1976.218612. S2CID 11184882.

Wilson, G. (2008). Our knowledge ourselves: Engineers (re) thinking technology in development. Journal of International Development, 20(6),739-750.

World Bank (2008). Global economic prospects 2008: Technology diffusion in the developing world. Washington DC: WorldBank

World Intellectual Property Organization (WIPO) (2016). Understanding Industrial Property. World Intellectual Property Organization. doi:10.34667/tind.36288. ISBN 9789280525939. Retrieved 17 June, 2024.

World Intellectual Property Organization (WIPO) (2024). What is Intellectual Property? https://www.wipo.int/about-ip/en/

World Trade Organization (2024). What are intellectual property rights? https://www.wto.org/english/tratop_e/trips_e/intel1_e.